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FINAL
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED PLAN OF MINING AND RECLAMATION

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EAST DECKER AND NORTH EXTENSION MINES
DECKER COAL COMPANY
BIG HORN COUNTY, MONTANA

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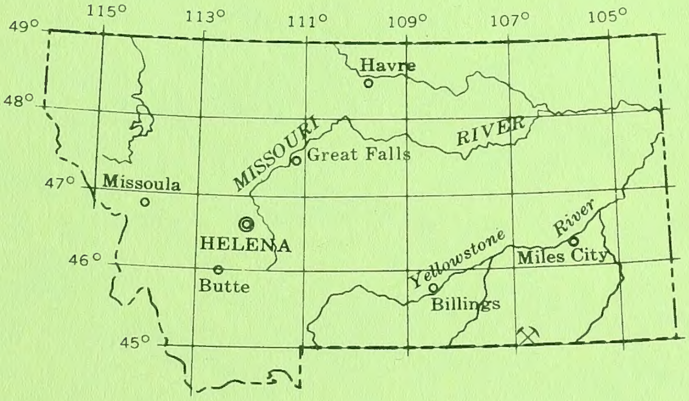

March 3, 1849

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

June 13, 1977

Enclosed is the final environmental impact statement (FES) on the proposed plan of mining and reclamation for the East Decker and North Extension mines, Decker Coal Company, Big Horn County, Montana (FES 77-20). This FES was jointly prepared by the U.S. Department of the Interior, Geological Survey and by the State of Montana, Department of State Lands. A draft environmental impact statement (DES) for the proposed plan was issued on October 29, 1976. Public hearings on the DES were held in Billings, Montana, at the Squirrel Creek School near Decker, Montana; and at the Sheridan, Wyoming, on November 16, 17, and 18, 1976, respectively.

Major additions or changes incorporated in the FES include:

1. Expanded discussion of Alternate Mining Plan B (Plan B-3 in the DES) for the proposed East Decker mine and deletion of the discussion of Alternate Plans B-1 and B-2, which have been dropped from further consideration.
2. Expanded discussion of the archeological and recreational resources in the Decker area.
3. Expanded discussion of possible mitigating measures for socioeconomic impacts on the Sheridan, Wyoming area.
4. Expanded discussion of the impacts caused by long-distance transportation of coal from the Decker area.
5. Responses to written and oral comments received regarding the DES. Public comments on the DES were used to expand and clarify many portions of the environmental statement.

This document was prepared in compliance with the National Environmental Policy Act and the Montana Environmental Policy Act. On June 13, 1977, copies of the FES were filed with the President's Council on Environmental Quality, the Governor of Montana, and the Montana Environmental Quality Council. Decisions on the Decker Coal Company's proposed mining and reclamation plans for the East Decker and North Extension areas will not be made until 30 days have elapsed following the filing of the FES with the above agencies.

It is suggested that the number of this statement and the date be entered on the document for reference purposes.

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NRIS 431

SUMMARY

( ) Draft (X) Final Environmental Statement

Department of the Interior, U.S. Geological Survey
Montana Department of State Lands

1. Type of action: (X) Administrative ( ) Legislative

2. Brief description of action

Federal and State action on proposed East Decker and North Extension mines, Decker Coal Co., Big Horn County, Montana. Company proposes (1) opening a new mine complete with a railroad spur, plant, and loading facilities in the East Decker area and (2) opening a major northern expansion of the existing West Decker mine that would use existing West Decker mine facilities. To facilitate mining, the Company also proposes relocating short sections of a Federal-aid-secondary highway and an unpaved county road. An estimated 180 million tons of low-sulfur coal would be removed from an area of about 3,500 acres over a period of about 20 years and shipped to Illinois, Michigan, and Texas for use in electric power-generation plants.

The major actions of the Federal and State governments that would significantly affect the quality of the human environment are:

a. The Department of Interior may approve or disapprove mining and reclamation plans for the proposed East Decker and North Extension mines pursuant to 30 C.F.R. Part 211.
b. The Montana Department of State Lands may grant or deny surface-mining permits for the proposed East Decker and North Extension mines pursuant to Chapter 10, Title 50, R.C.M. 1947.
c. The Montana Department of Health and Environmental Sciences may approve or deny a permit for the construction of coal-handling facilities in the East Decker area pursuant to Chapter 39, Title 69, R.C.M. 1947.
d. The Montana Department of Highways may approve or disapprove the relocation of a short section of Route FAS 314 pursuant to Chapter 22, Title 32, R.C.M. 1947.

3. Summary of adverse, unavoidable environmental impacts

A. Shallow aquifers would be permanently removed within the mined interval, and local water quality would be lowered by leaching of spoils and erosion. Effects of lowered water quality on the Tongue River Reservoir and any reduction of annual runoff to the Tongue River Reservoir should be insignificant.

B. Postmining surface would be slightly lower; soils would be removed, mixed, altered, and replaced on 4,000 to 5,000 acres. Disturbed areas would experience unavoidable loss of productivity during the period of disturbance and some lesser loss of productivity until complete rehabilitation is accomplished.

C. Mining, coal-processing and coal-transport operations would cause short-term localized reduction in air quality. Scenic views and open-space qualities would be locally degraded until reclamation is completed.

D. Long-term rearrangement in size, area, and location of vegetative community types would occur. Approximately 6,300 acres of grazing land would be lost to use, at least until the proposed projects are completed.

E. Wildlife habitat losses would occur until mining activities cease and disturbed areas are successfully revegetated. These losses possibly might be long-term. Antelope and sage grouse would be severely affected at least for the short-term. Human activity associated with the mining operations would also impose some short-term impacts on wildlife.

F. State and local Montana governments are calculated to have sizeable revenue surpluses from the proposed mines whereas Wyoming governments would experience deficits. Quick resolution of this problem is unlikely because of the unprecidented coordination and cooperation necessary to transfer funds from one of these States to the other.

G. Mining-related population growth in the Sheridan area would cause at least short-term impacts on housing availability and cost. Lag would occur in the ability of Sheridan to provide adequate community services to an increased population.

4. Alternatives considered

A. Administrative alternatives available to the Secretary of the Interior.
B. Administrative alternatives available to State Agencies.
C. Alternate mining plans A and B for the East Decker area.
D. An alternate mining plan for the North Extension area.
E. Technologic alternatives available to Federal and State authorities.
F. Development and use of alternative sources of energy.
G. Alternatives that do not provide equivalent energy.

5. Comments have been requested from (see summary attachment).

6. Data made available to the Governor of Montana, Montana EQC, Federal CEQ and the public:

Attachment:

Comments were requested from the following:

Federal agencies

- * Advisory Council on Historic Preservation
- * Soil Conservation Service
- * Federal Power Commission
- * Environmental Protection Agency
- * Department of Health, Education, and Welfare
- Interstate Commerce Commission
- * Forest Service
- * Federal Energy Administration
- Federal Highway Administration
- * Energy Research and Development Administration
- * Department of the Army
- Department of the Interior
  - * Bureau of Outdoor Recreation
  - * Bureau of Mines
  - * Bureau of Land Management
  - * Fish and Wildlife Service
  - Bureau of Reclamation
  - Bureau of Indian Affairs
  - Mining Enforcement and Safety Administration

State and local agencies

- Office of the Governor, Montana
- Office of the Governor, Wyoming
- Montana Agricultural Experiment Station
- * Montana Department of Community Affairs
- Montana Department of Revenue
- Montana Energy Advisory Council
- Montana Environmental Quality Council
- * Montana State Historic Preservation Officer
- Montana Bureau of Mines and Geology
- Board of County Commissioners, Big Horn County, Montana
- Board of County Commissioners, Rosebud County, Montana
- * Board of County Commissioners, Sheridan County, Wyoming
- Mayor, City of Sheridan

Applicants

- * Decker Coal Company

* Indicates that written comments on the Draft Environmental Statement were submitted.

Other organizations

  Sierra Club
  Environmental Defense Fund
  Natural Resources Defense Council
  National Audubon Society
* Northern Plains Resource Council
* Tri-County Ranchers Association
  Friends of the Earth
  Rosebud Protective Association
* Powder River Basin Resource Council
* Montana Coal Council
  League of Women Voters of Montana
  Environmental Information Center
  Montana League of Conservation Voters
  Tongue River Water Users Association
  Crow Tribal Council
* Northern Cheyenne Tribal Council
  Western Environmental Trade Association

* Indicates that written comments on the Draft Environmental Statement were submitted.

U.S. DEPARTMENT OF THE INTERIOR
MONTANA DEPARTMENT OF STATE LANDS

FINAL
ENVIRONMENTAL IMPACT STATEMENT
PROPOSED PLAN OF MINING AND RECLAMATION
EAST DECKER AND NORTH EXTENSION MINES
DECKER COAL COMPANY
BIG HORN COUNTY, MONTANA

Prepared by

U.S. Geological Survey, Department of the Interior

Montana Department of State Lands

Commissioner
Montana Department of State Lands

V. E. McKelvey

Director
U.S. Geological Survey

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INTRODUCTION

Preface

This statement was prepared by the U.S. Geological Survey and the Montana Department of State Lands (lead State agency) and represents a joint analysis of cumulative environmental impacts of proposed new coal-resource development by the Decker Coal Co. in the area adjacent to the Tongue River Reservoir in Big Horn County, Montana. The joint statement considers the primary, secondary, and cumulative impacts of the Decker Coal Co. proposals.

Decker Coal Co. has been extracting coal by surface-mining methods from its West Decker mine since 1972. This mine produced about 9 million tons of coal in 1975, all of which was exported by rail to electric generating plants in Illinois. Production from this mine is expected to rise to 10 million tons per year in 1976 and to continue at about that rate until the coal resource is depleted.

Decker Coal Co. holds additional leases on State and federally-owned coal deposits in the Decker area and has submitted proposed plans (1) for opening and operating one additional mine in the area, (2) for major expansion of an existing mine, and (3) for needed rail and highway easements. Appropriate applications have been made to the Montana Department of State Lands, to the Montana Department of Natural Resources and Conservation, to the Montana Department of Highways, and to the U.S. Geological Survey for approval of these plans and easements in accordance with existing State and Federal laws. In addition, the Decker Coal Co. will participate in a competitive coal lease sale to be held by the Bureau of Land Management tentatively in May 1977. This sale is for the coal underlying those lands lying between the company's existing lease boundaries and the Tongue River

Reservoir in sec. 34, T. 8 S., R. 40 E., and sec. 3, T. 9 S., R. 40 E. (fig. 1). Proposed plans described in section I of this statement include the opening of a new mine on existing leases on the east side of the Tongue River Reservoir (East Decker area) and a major expansion of present mining onto existing Federal and privately-owned coal leases on the west side of the reservoir immediately north of the existing West Decker mine (North Extension area). These plans do not include mining on lands in sections 3 and 34 for which a competitive lease sale must be held. Total production from the two mines is expected to reach 9 million tons per year in 1979 and to continue at that rate for a period of about 20 years.

In addition, the Decker Coal Co. has proposed an alternate mining plan for the North Extension area should a lease be obtained for lands in sections 3 and 34 prior to initiation of mining on the existing leasehold. This alternate plan is evaluated in section VIII. F. Also, an alternate mining plan for the East Decker area, in which only State and privately-owned coal would be mined, has been submitted by the Decker Coal Co. for evaluation in the event that legal restraints prevent or delay the mining of Federal coal in this area. This Alternate Mining Plan A for the East Decker area is discussed in section VIII. D.

Development of Federal coal-resource holdings under lease in the area requires approval of mining and reclamation plans by the Geological Survey, Department of the Interior, prior to implementation.

The Montana Department of Natural Resources and Conservation and the Montana Department of State Lands have jurisdiction over State land holdings in the area, including authorizations for railroad and highway easements and the mining of State-owned coal. In addition, Montana statutes require that the Department of State Lands must approve the proposed mining and reclamation plans prior to initiation of mining operations. In keeping with that responsibility, the Department of State Lands in March 1976 expressed strong dissatisfaction with the Decker Coal Co.'s plan to spoil into Deer Creek valley and to fill the center of the railroad loop as proposed in both the original plan and Alternate Mining Plan A for the East Decker area. The Department regards the Deer Creek valley as having special, exceptional, critical or unique characteristics. Disturbance of such areas in conjunction with strip mining is prohibited in section 9 of the Montana Strip and Underground Mine Reclamation Act. The Department also expressed dissatisfaction with the proposed final topography and plans for reestablishment of stable stream channels. Accordingly, the Decker Coal Co. was asked to modify their proposals for the East Decker area so as to avoid spoiling into Deer Creek valley and to correct the other indicated deficiencies. The Company subsequently submitted three alternate mining methods for preliminary appraisal by the Reclamation Division. The most promising of these proposals, which would best achieve state reclamation objectivies and provide for maximum feasible recovery of the coal resource, is evaluated at length in section VIII. E.

Other related activities are expected should State and Federal approval actions ensue, such as roadways and other transportation and communication facilities, new residence and business communities, and increased facilities of all kinds in existing communities. Many of these activities may require additional State or Federal authorizations.

Responsible State and Federal agencies have determined that approval of the Decker Coal Co.'s pending applications would constitute major State and Federal actions that would significantly affect the quality of the

the human environment. Therefore, these agencies have determined that joint preparation of a single environmental impact statement would effectively protect the public interest and would most efficiently meet the individual, but essentially identical, responsibilities of these agencies under the National Environmental Policy Act of 1969 (NEPA) and the Montana Environmental Policy Act of 1971 (MEPA). Because of the primary responsibilities of the U.S. Geological Survey and the Montana Department of State Lands for the approval and administration of mining and reclamation plans submitted by the Decker Coal Co., these agencies were assigned coleadership roles in the preparation of a joint environmental impact statement. The Bureau of Land Management, because of the comparatively small amount of public lands in the Decker area (about 240 acres in the North Extension project area; none in the East Decker project area), elected to participate largely in an advisory capacity with responsibility for technical review. Input from Montana Department of Natural Resources and Conservation, Montana Department of Highways, and Montana Department of Fish and Game was obtained through contractual agreements with the Department of State Lands. Socio-economic impacts were appraised by the Institute for Social Research of the University of Montana and by Paul Polzin, economist, through contractual agreements with the Department of State Lands. Supplemental data furnished by Decker Coal Co. and compiled by VTN Colorado in cooperation with Decker Coal Co. personnel were used where applicable.

The NEPA and MEPA processes have been successfully concluded for several mining activities in this general area in recent years; a new mining plan for the Sarpy Creek (Absolaka) mine is presently under evaluation. The Montana State Lands Department is required by the Montana Strip and

Underground Mine Reclamation Act to render a decision on pending coal or uranium surface-mining permit applications within a stringent time constraint. Hence, the primary geographic scope of this statement is restricted to the Decker leases and to the direct and indirect impacts of the Decker proposals, although secondary impacts having a broader geographic scope, such as social and economic factors, atmospheric influence, water resources, and recreation uses are necessarily treated on a larger geographic basis. This statement discusses the existing environment, evaluates the collective impacts of the proposed actions, and describes mitigating measures and alternative courses of action.

An especially significant element of the analysis involves assessing the extent to which the proposed mining program would impact other current activities in the area and constrain future, and substantially different, development proposals for the area.

Agency responsibilities and interagency relationships

Responsibilities of Montana State agencies

Department of State Lands

The Montana Board of Land Commissioners[1/] (Board) and Montana Department of State Lands[2/] (Department) have three principal responsibilities with regard to the Decker Coal Co. proposals: (1) Administration of State coal leases, of which there are six within the two project areas, (2) administration of the Montana Strip and Underground Mine Reclamation Act, and (3) administration of the Montana Coal Conservation Act.

[1/] The Board of Land Commissioners consists of the Governor, Attorney General, Superintendent of Public Instruction, State Auditor, and Secretary of State.

[2/] The Commissioner of State Lands is the chief administrative officer for the Department of State Lands and is appointed by and serves at the pleasure of the Governor.

As provided by Federal law (25 Stat 676), lands granted by the Federal government to the State are trust lands given for the support of schools and other public institutions. Accordingly, the Board, through the Montana Constitution, is given authority to direct, control, lease, exchange, and sell these trust or "school" lands.[1/] Although decisions involving school lands, including the sale of coal leases, are made by the Commissioner of State Lands, all such decisions are subject to the approval of the Board.

The Board must enforce the requirements specified in the coal leases (see Appendix A) and all coal lease requirements as described in Chapter 50, Title 81 R.C.M. 1947. A violation of lease conditions is grounds for forfeiture of a lease, but not before the lessee has received a hearing before the Board. The Board may also prescribe such additional rules and regulations as it finds necessary and proper relating to the leasing of State lands for coal-mining purposes.

Pursuant to its duties as administering agency for the Montana Strip and Underground Mine Reclamation Act (Chapter 10 Title 50, R.C.M. 1947), the Department must review and then grant or deny a surface-mine permit or permit amendment within 240 days after the submission of a complete permit application. The Department reviews applications for conformance with provisions of the Reclamation Act regarding the method of operation, susidence stabiliation, water control, backfilling, grading, highwall reduction, top-soiling and for the reclamation of lands affected by the proposed mining

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[1/] Not all State lands are "school" lands; however, all State lands in the proposed East Decker and North Extension mine areas are school lands.

operations. The Board may adopt rules to accomplish the purpose of the Reclamation Act, and the Department may adopt rules with respect to the filing of reports and the issuance of permits. To ensure compliance with the Reclamation Act and rules adopted pursuant to the Act, the Department is required to make mine inspections and investigations as necessary.

The Department may not approve strip mining in areas which meet the criteria for selective denial provisions as specified in section 9 of the Reclamation Act. The Department may conduct studies or encourage others to conduct studies of strip mining and strip-mined land reclamation.

When the operator is not in compliance with requirements of the Reclamation Act, rules pursuant to the Act, or orders of the Department and has not achieved compliance within time limits set by the Department, the Commissioner shall serve a notice of noncompliance on the operator or, if necessary, he shall order the suspension of the permit. After a hearing, the Board shall order the Department to revoke the permit if requirements specified in the notice of noncompliance, in the order of suspension, or in an order of the Board requiring remedial measures have not been satisfied.

In addition to its duties under the Reclamation Act, the Department must approve or disapprove strip-mining plans as required by the Montana Strip Mined Coal Conservation Act, (Title 50, Chapter 14 R.C.M. 1947). The Department may require an operator to submit, in addition to the mining plan, any information it deems necessary to determine whether waste of the coal resource would occur. The Board may adopt rules to prevent waste and to effectuate the intent and purposes of the Act, and the

Department must adopt procedures for the submission of strip-mining plans and a format for the preparation of such plans. In addition, the Department may make such inspections and investigations it deems necessary for review of a strip-mining plan.

Department of Natural Resources and Conservation

Department of Natural Resources and Conservation administers the Tongue River Reservoir Project, which is State owned. The project, consisting of a dam and storage reservoir located about ten miles north of the Montana-Wyoming border near Decker, Montana, is operated by the Tongue River Water User's Association. The primary purpose of the project is to provide a reliable source of irrigation water for downstream users. The reservoir receives considerable recreational use, and water has been sold for industrial purposes. The Department of Natural Resources and Conservation's responsibility in this matter is to protect the project from any damages that could result from the Decker Coal Co. proposals.

Department of Highways

Decker Coal Co.'s proposal for the North Extension area would require relocation of Federal-Aid Secondary Highway, Route FAS 314. The Montana Department of Highways is designated the custodian of such highways by Section 32-2202, R.C.M., 1947. Additions or deletions in mileage or relocation of Route FAS 314, therefore, require the approval and cooperation of the Montana Highway Department, the Montana Highway Commission, the Federal Highway Administration, and the Board of County Commissioners.

In making decisions on highway actions, including systems changes, the Department of Highways must comply with the Montana Environmental

Policy Act, the National Environmental Policy Act, and Federal Highway Administration regulations concerning public hearings, location, design, and environmental impact statements.

Department of Health and Environmental Sciences

Under the Clean Air Act of Montana (Chapter 39, Title 69, R.C.M. 1947), the Department of Health and Environmental Sciences is assigned the responsibility for assuring the prevention, abatement and control of air pollution in Montana. The Clean Air Act authorizes the Department to conduct studies and undertake research related to air pollution and to consult with persons proposing to create air-contaminant sources. Rules adopted pursuant to the Act require that separate permits must be obtained from the Department for the construction and for the operation of coal-handling facilities (crushing, storage, and loadout). Accordingly, the Department of Health and Environmental Sciences must issue an air-quality construction permit to the Decker Coal Co. for the proposed coal-handling facilities at the East Decker mine and an operating permit for those facilities once they are completed and coal production begins. In addition, the Decker Coal Co. must obtain an operating permit for their existing West Decker coal-handling facilities. The Department of Health and Environmental Sciences is currently processing such a permit.

In addition to issuing construction and operating permits for the East Decker coal-handling facilities, the Department of Health and Environmental Sciences is also responsible for monitoring both mining and coal-handling operations in the East Decker and North Extension areas to insure compliance with both ambient air-quality standards and regulations adopted pursuant to the Clean Air Act.

Relationships among State agencies

Three State agencies, the Department of State Lands, the Department of Highways, and the Department of Health and Environmental Sciences, have decisions to make in regard to the two Decker Coal Co. proposals that require environmental review under the Montana Environmental Policy Act. These three agencies are cooperating in this impact statement to fulfill their MEPA obligations. The Department of Natural Resources and Conservation does not have a decision to make which requires review under MEPA, but is cooperating in this impact statement to help anticipate and solve possible problems in regard to the Tongue River Reservoir.

Responsibilities of and relationships between Federal agencies

U.S. Geological Survey and Bureau of Land Management

The Secretary of Interior has delegated to the U.S. Geological Survey (USGS) and the Bureau of Land Management (BLM) certain responsibilities in the Public Lands lease management activities of the Department of Interior. These responsibilities are designated in Secretarial orders, in regulations, and in the Departmental manual.

On October 6, 1972, the Secretary of Interior issued Order number 2948 to update the division of responsibilities between the USGS and the BLM in the Department's Mineral Management Program. Under this order, the BLM exercises the Secretary's discretionary authority to determine whether or not leases and permits are to be issued. The BLM, in cooperation with the USGS, formulates requirements to be incorporated in leases and permits that would protect the surface and nonmineral resources. The BLM reviews exploration and mining plans submitted for approval to the USGS, and determines the adequacy of surface use, environmental protection, and reclamation aspects of these plans. The BLM is responsible for making examinations outside the area of operations to assure compliance with environmental protection requirements. Infractions are reported to the USGS for resolution, either by discussion with or by issuance of orders to the operator. Access roads and other requests for surface use outside the area of operations, but on the lease, are approved by the USGS with BLM concurrence. All operations by the lessee, his operators, or assigns on the lease are covered by the lease terms. Operations off the lease or on the lease by other than the lessee require a right-of-way, special land-use permit (SLUP), sale request, etc., application to the BLM. BLM consults with the USGS when these applications affect operations on the leases. Instructions to the lessee or operator on the lease are made through the USGS, except in an emergency. BLM can, in an emergency, give the lessee or operator instructions but must notify the USGS immediately.

The USGS exercises the Secretary's delegated authority regarding mining and related activities conducted within the area of operations and determines actions to be taken by operators for development, conservation, and management of mineral resources under Departmental jurisdiction. In addition, the USGS approves or disapproves exploration and mining plans after consultation with the BLM. The USGS examines operations to ensure compliance with environmental protection and reclamation requirements and, if necessary, issues orders for compliance within the operating area.

Once an exploration or mining plan is approved, the Area Mining Supervisor of the USGS must make on-site inspections at least quarterly to assure compliance with lease terms, regulations, and approved exploration or mining plans. The purpose of this supervision is to assure the orderly and efficient development of minerals on Federal lands. A report is written following each inspection stating whether or not the operator is in compliance with lease terms, operating regulations, and the approved plan. If the operator is not in compliance, recommendations and steps ordered to achieve compliance are enumerated. The report is placed on file for public examination at the office of the Mining Supervisor, excluding those parts that contain trade secrets or privileged financial, commercial, geological, or geophysical information.

The District Manager of the BLM also must make compliance checks and report any infractions to the Area Mining Supervisor. These inspections are conducted primarily to assure that surface disturbances are not excessive. Emphasis is placed on the location, method, and effectiveness of waste-disposal facilities and on proper and timely reclamation of disturbed areas to minimize erosion and to blend reclaimed areas into the surrounding topography. The density and types of plants used in revegetation are noted, as well as the results obtained.

The Area Mining Supervisor of the USGS must discuss any observed violations with the operator and require suitable correction within a specified time period. Observed violations are confirmed in writing to the company and to the Mining Supervisor's superiors. These reports are made part of the public record on file at the office of the Mining Supervisor. If violations are not corrected within the specified time, the Mining Supervisor may suspend operations, or he may request that the BLM initiate action to cancel the lease or permit. The inspection also includes a check of production and sales records to assure that the U.S. Government is receiving the proper royalties. The Area Mining Supervisor and the District Manager of the BLM are encouraged to make periodic inspections jointly.

Current mine maps are required annually, or at such other times as the Mining Supervisor may request. A report describing the acreage disturbed and reclaimed is required annually. An audit of the operator's financial records by a Certified Public Accountant may be required annually, or at other such times as may be directed by the Mining Supervisor.

Relationships between State and Federal agencies

The U.S. Geological Survey and the Bureau of Land Management must comply with the National Environmental Policy Act (NEPA) in making their decisions regarding the Decker Coal Co. proposals. The Department of State Lands and the Department of Health and Environmental Sciences, in turn, must comply with the Montana Environmental Policy Act (MEPA) in making their decisions. The Department of Highways must comply with both acts in making its decisions. The primary objective of this cooperative impact statement is to fulfill both State and Federal agencies' requirements under NEPA and MEPA. The relationship between State and Federal agencies, therefore, has been one of voluntary cooperation rather than one dictated by statute or other mandate.

On May 17, 1976, the Department of the Interior adopted new coal mining operating regulations (30 C.F.R. Part 211 and 43 C.F.R. Part 3041) to govern the management of federally-owned coal resources. These regulations establish a procedure under which the Secretary of Interior may decide, through rule making, that the Department will approve mining plans in a particular state only if the mining plan would comply with the requirements of state reclamation laws which the Secretary has determined are as stringent as the reclamation requirements of the new Federal coal mining operating regulations.[1/] The new Federal coal mining operating regulations also provide for the Department of the Interior to consult with appropriate State representatives and enter into agreements establishing a joint program for the administration and enforcement of surface coal mining reclamation operations on Federal lands.

On June 23, 1976, the Secretary of the Interior established a task force to review the requirements of the state reclamation laws in comparison with those of Federal regulations and to make preliminary recommendations as to whether compliance with requirements of these various states' laws should be made a condition of approval of a Federal mine plan under 30 C.F.R. Part 211.

After completing its review of the requirements of Montana's Strip and Underground Mine Reclamation Act, the Department of Interior proposed to adopt four of the Act's sections and to enter into a joint agreement for the administration and enforcement of reclamation requirements on those surface coal mine operations on Federal lands. Public hearings on the adoption of those four sections by the Secretary of the Interior have twice been postponed. In the interim Federal and State offficals have begun negotiating an agreement that would provide for the State enforcement of reclamation requirements on federally owned lands. Those negotiations had not been concluded as of the date this final statement was printed.

[1/] Pursuant to 30 C.F.R. 211 and 43 C.F.R. 3041, a "mining plan" must include proposed methods for both mining and reclamation. Pursuant to Title 50, Chapter 10 R.C.M. 1947 a "surface mining permit application" includes both a proposed plan for mining and a proposed reclamation plan.

Negotiations between Montana and Department of Interior officials pursuant to 30 C.F.R. 211.75 are continuing. In the interim Federal administration and enforcement of Federal regulations will continue with respect to the mining of federally-owned coal in Montana. It is the Department of Interior's position that review of state reclamation requirements as provided for by 30 C.F.R. 211.75 does not affect Montana's right to regulate reclamation under state laws and regulations.

As of March 1977, the original proposed mine plans for the East Decker and North Extension areas have not been withdrawn by the applicant. Very probably, however, the plans that will be considered most favorably by the Department of State Lands are Alternate Mining Plan B for the East Decker area and the alternate mine plan for the North Extension area that provides for recovery of the coal in sections 3 and 34. Alternate Mining Plan B, would mitigate most identified adverse impacts in the East Decker area to a greater extent than would the original proposal. The Alternate Mining Plan for the North Extension area would have essentially the same impact on the environment as the original proposal. Both alternate plans have been reviewed by the Area Mining Supervisor for compliance with the requirements of 30 C.F.R. 211.10(c), and he has found that they meet those requirements. In addition, the State finds that these plans include all information required to constitute a complete application under the Montana Strip and Underground Reclamation Act and rules adopted pursuant thereto.

I. DESCRIPTION OF THE PROPOSALS AND EXISTING COAL MINING IN THE AREA

A. Proposals of the Decker Coal Co.

This section was prepared solely on the basis of information and maps supplied by Decker Coal Co. and represents their proposal to the U.S. Geological Survey and the Montana Department of State Lands for new coal-mining operations.

1. Existing coal-resources holdings, Decker Coal Co.

The Decker Coal Co. presently has about 17,530 acres of coal lands under lease, either directly or by agreement with other leaseholders. Lands under lease lie on both sides of the Tongue River Reservoir in southeastern Montana. Of the total, 14,370 acres are under Federal lease, 2,760 acres are under State lease, and the remaining 400 acres are under fee (private) lease. This great preponderance of Federal over non-Federal holdings reflects the primary contiguous Federal coal ownership in this area, which lies outside the alternate section (checkerboard) coal ownership area of the railroad land grants. The development of large-scale surface mining in the Decker area, therefore, must occur primarily on Federal coal. Leased areas are shown in figure 1. Lease numbers are given for Federal and State leases. Surface ownership and coal ownership in the Decker area are shown in figures 1A and 1B, respectively.

a. Total reserves

Estimates based on exploration work to date indicate that total recoverable coal reserves underlying lands leased by the Decker Coal Co. are about 471 million tons. Recoverable reserves are herein defined as "that part of the Identified Coal Resource that can be economically mined at the time of determination." (U.S. Bureau of Mines and U.S. Geological Survey, 1976).

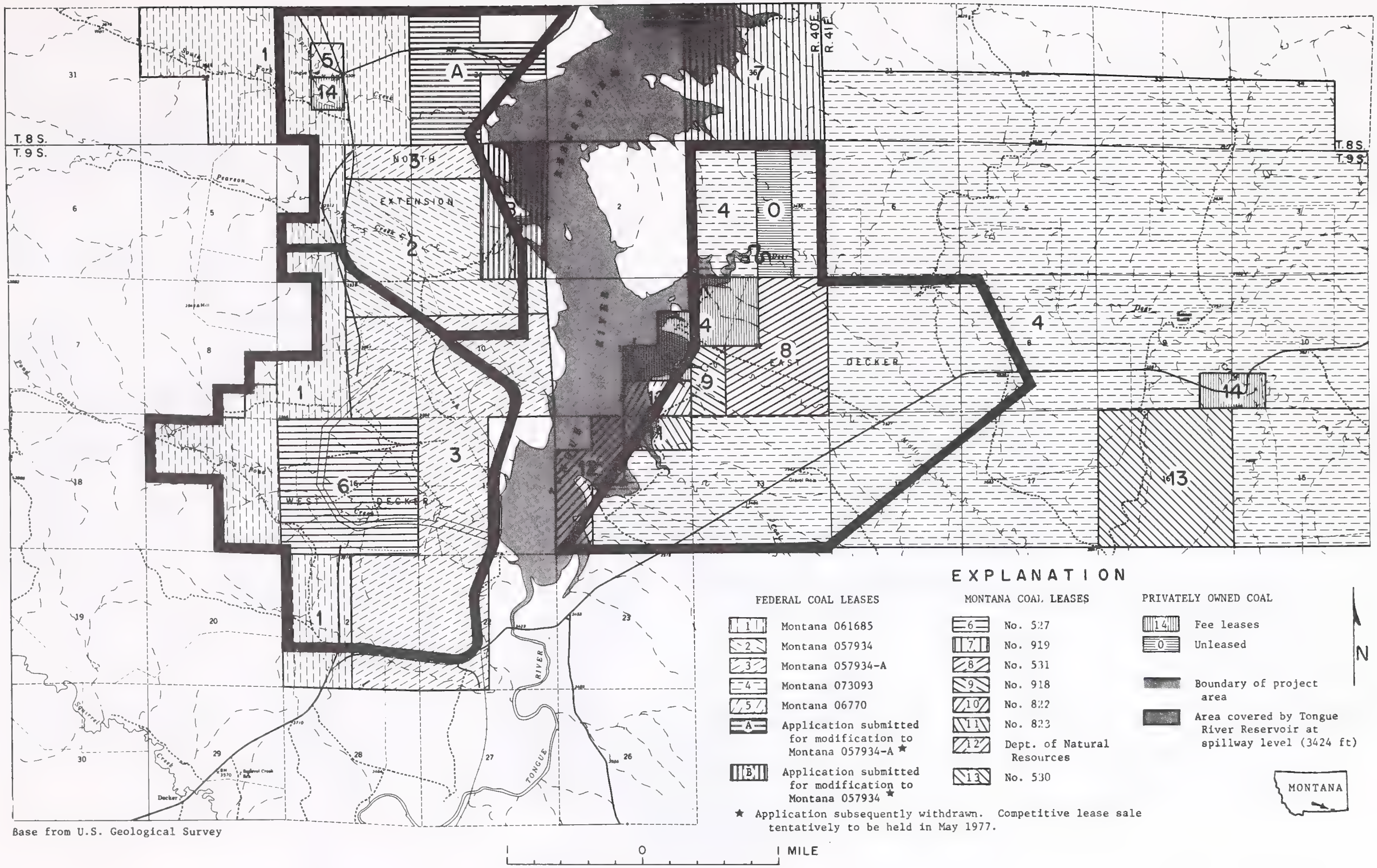
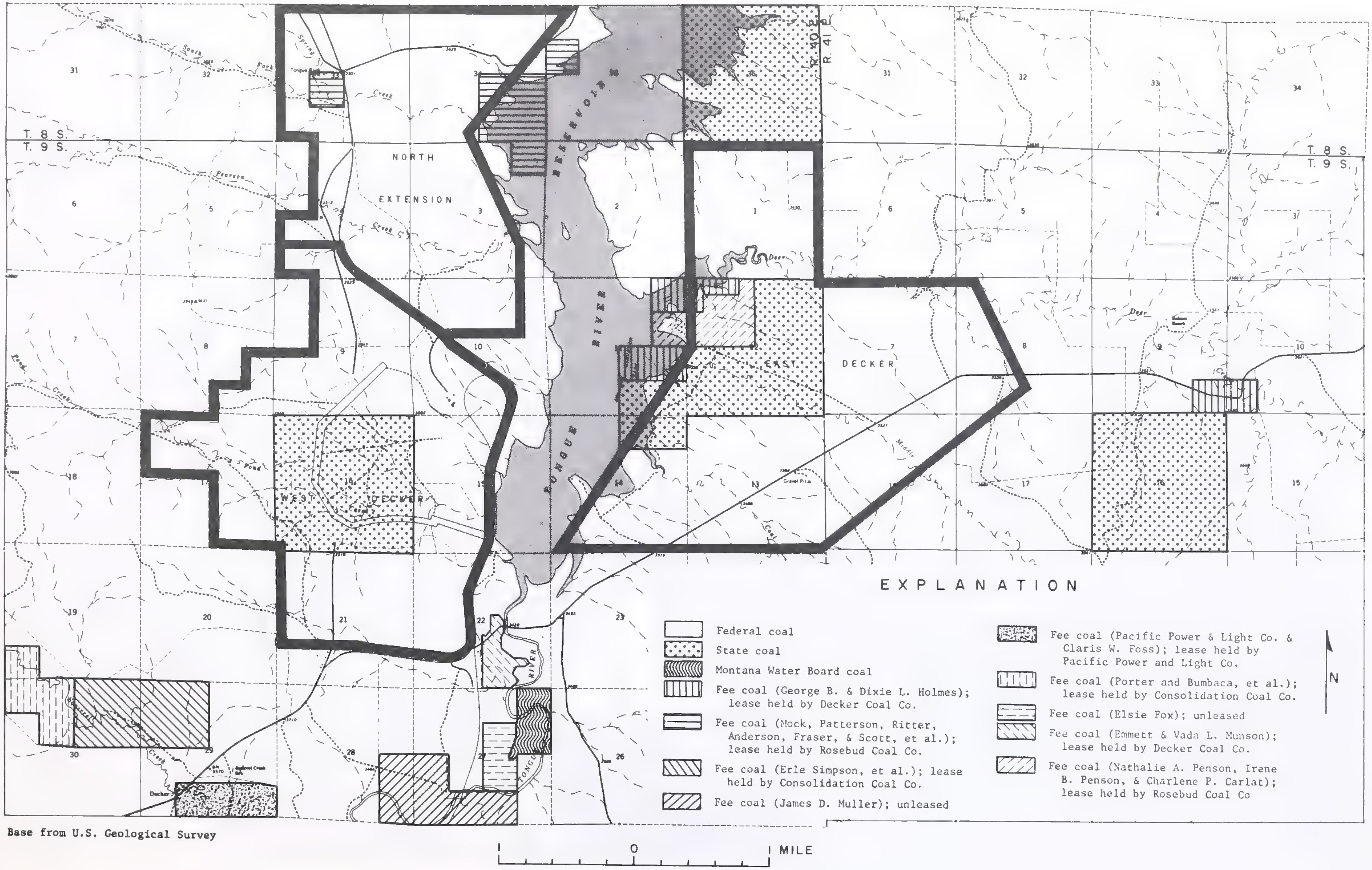


Figure 1.—Coal leases held or controlled by the Decker Coal Company in the Decker area, Big Horn County, Montana.


T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
NORTH EXTENSION
EAST DECKER
WEST DECKER
DECKER
TONGUE RIVER RESERVOIR
TONGUE RIVER
South Fork
Spring Creek
Pearson Creek
Pond Creek
Deer Creek
Middle
Coal
Gravel Pits
Decker
31
32
33
34
6
5
4
3
2
1
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23
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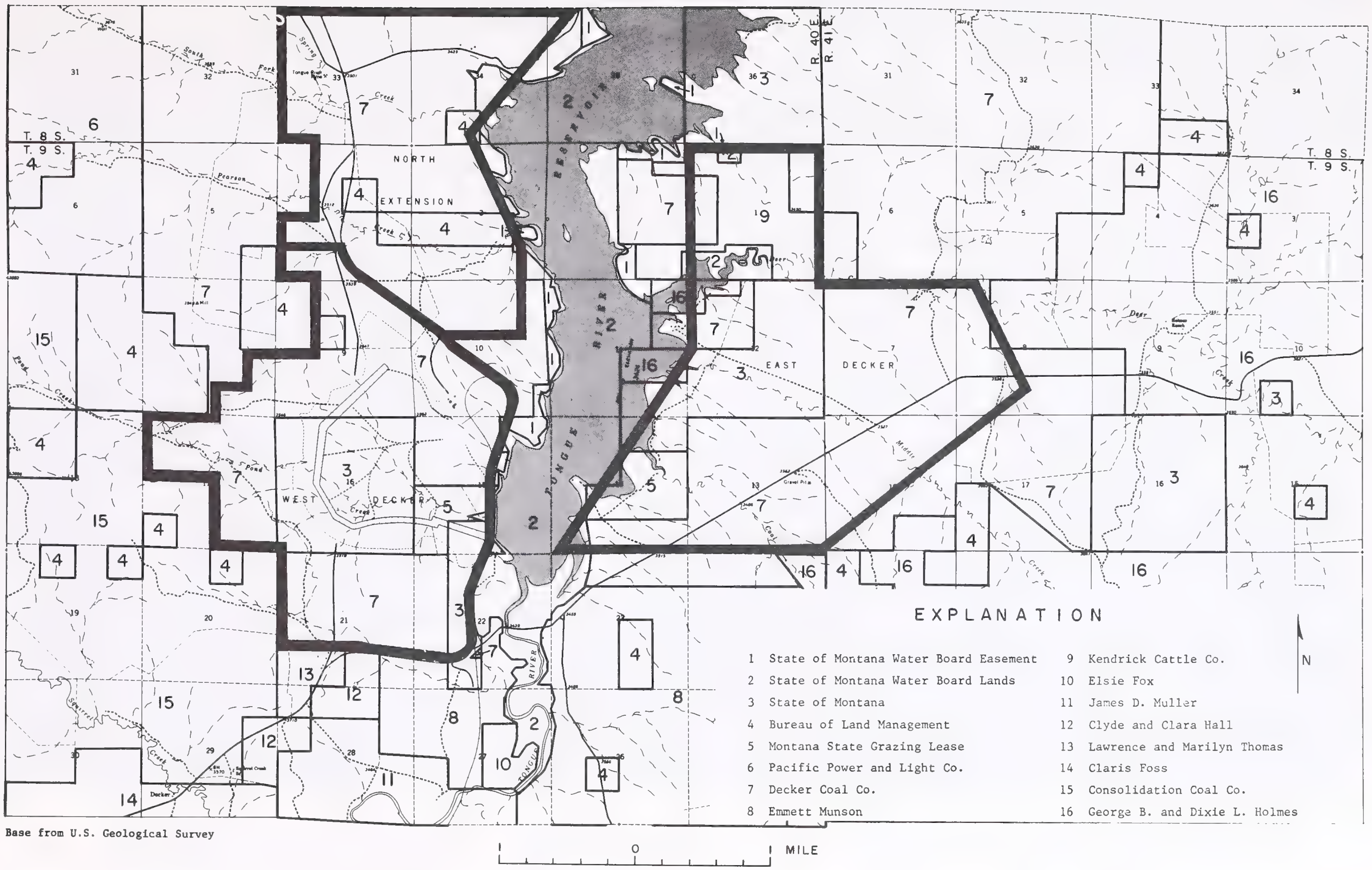
28
29
30
EXPLANATION
Federal coal
State coal
Montana Water Board coal
Fee coal (George B. & Dixie L. Holmes); lease held by Decker Coal Co.
Fee coal (Mock, Patterson, Ritter, Anderson, Fraser, & Scott, et al.); lease held by Rosebud Coal Co.
Fee coal (Erle Simpson, et al.); lease held by Consolidation Coal Co.
Fee coal (James D. Muller); unleased
Fee coal (Pacific Power & Light Co. & Claris W. Foss); lease held by Pacific Power and Light Co.
Fee coal (Porter and Bumbaca, et al.); lease held by Consolidation Coal Co.
Fee coal (Elsie Fox); unleased
Fee coal (Emmett & Vada L. Munson); lease held by Decker Coal Co.
Fee coal (Nathalie A. Penson, Irene B. Penson, & Charlene P. Carlat); lease held by Rosebud Coal Co
N
1 0 1 MILE

Base from U.S. Geological Survey

Figure 1A.- Coal ownership in the Decker area, Big Horn County, Montana.



Base from U.S. Geological Survey

Figure 1B.- Land (surface) ownership in the Decker area, Big Horn County, Montana.

b. Present operations

The Decker Coal Co. currently operates a surface coal mine called the West Decker mine, which is located on a State lease in sec. 16, T. 9 S., R. 40 E. and on portions of Federal leases Montana 061685 and Montana 057934-A in adjacent sections, (figs. 1 and 2). The mine opened in 1972 and currently is producing at an annual rate of about 10 million tons with a work force of 280 men. Reserves in this area are estimated to be about 106 million tons.

c. Proposed operations

Estimates of coal reserves in leased areas related to the two proposed mines described in this Statement are:

East Decker area	North Extension area
320 million tons	47 million tons

2. East Decker mine proposal

The proposal described in this section is the mining plan initially submitted by the Decker Coal Co. to the U.S. Geological Survey and to the Montana Department of State Lands (April 9, 1975). To date no official action on this proposal has been taken by either agency. In keeping with its responsibilities, however, the Reclamation Division of the Department of State Lands has reviewed Decker Coal Co.'s permit application in light of the requirements of the Montana Strip and Underground Mine Reclamation Act. As a result, the Department has reported several major deficiencies in this proposal (see p. 696-697). To correct such deficiencies, the Decker Coal Co. has submitted an alternate method of mining that also would significantly increase recovery of the coal resource. That alternative plan is described at length in section VIII. E.

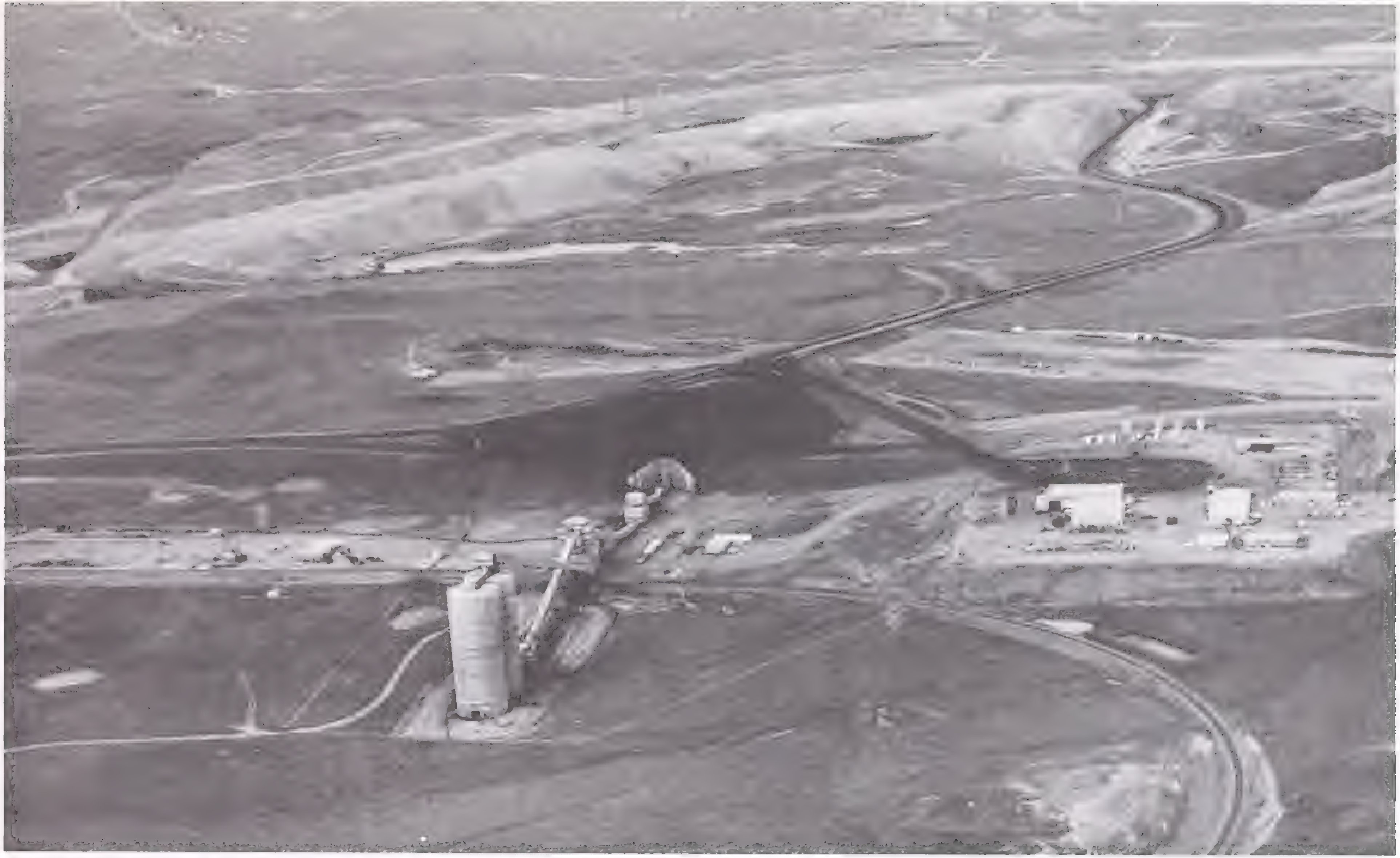


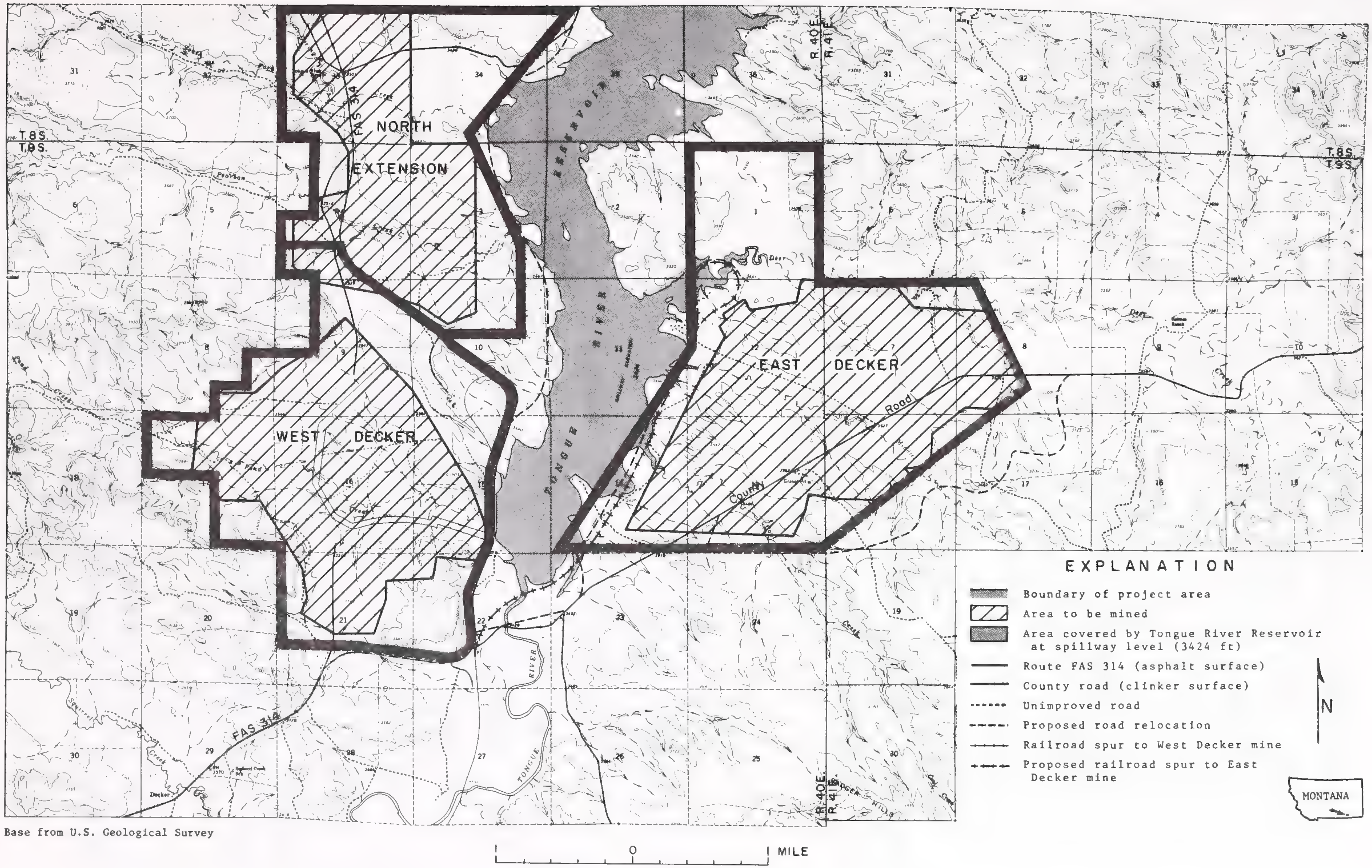
Figure 2.-West Decker mine, June 1975. View westward across the railroad loop, loading facilities, and plant area in the foreground toward the area being mined in the background (see also figs. 6 and 14).

Logic dictates that any approval of mining in the East Decker area would almost certainly require adoption of some form of the alternate plan rather than the original proposal. Not surprisingly, therefore, public review of the draft environmental statement raised the question, "Why include an evaluation of the initial proposal when it no longer appears to be viable?" The decision to retain this material in the final environmental impact statement is based partly on the fact that the initial proposal has not been withdrawn by the applicant. More important, however, the discussion of the original proposal and identification of its shortcomings, followed by the development of an alternate proposal to correct those deficiencies, provides an excellent example of the worth of the environmental analysis process and the positive role of regulatory agencies such as the Department of State Lands in that process.

a. Background

(1) Purpose

The Decker Coal Co. proposes to mine about 135 million tons of low-sulfur, subbituminous coal over a 20-year period from an area to be known as the East Decker mine. The Project area is on the east side of the Tongue River Reservoir in Big Horn County, Montana (fig. 3). Coal from this mine (about 6.7 million tons annually) would be transported by unit train to Austin, Texas (Lower Colorado River Authority) and to Chicago, Illinois (Commonwealth Edison) where it would be used for electric-power generation. Environmental Protection Agency sulfur emission standards currently limits emissions from power plants to 1.2 pounds of sulfur dioxide (SO_2) per million Btu fired. A comparison of relative sulfur characteristics



Base from U.S. Geological Survey

Figure 3. - Existing West Decker project and mine area and proposed East Decker and North Extension project and mine areas.

of coal from the East Decker area with Illinois coal, which has been the traditional coal source in the Midwest, is shown in the following table:

	Btu	Sulfur (%)	SO_2 in flue gas (lbs/million Btu)
East Decker [1]	9,500	0.48	1.0
Illinois [2]	11,300	2.94	5.2

[1] Average of the 3 minable beds.

[2] U.S. Bureau of Mines (1972b)

The fact that coal from the proposed East Decker mine would meet EPA SO_2 emission standards[3] is the main reason for its use by electric utilities. Additional data on physical and chemical characteristics of the coal are presented in Appendix B.

(2) History

A competitive coal-lease sale was held on June 29, 1966, in the Bureau of Land Management office in Billings, Montana. A successful oral bid of $18.25 per acre or $171,724.47 for the entire lease of 9,409.56 acres was made by Peter Kiewit Sons' Co. On September 1, 1971, this Federal coal lease (Montana 073093, Appendix A) was assigned to Decker Coal Co. a joint venture in which Peter Kiewit Sons' Co. is managing partner.

The Federal coal lease now held by Decker Coal Co. is perpetual and provides for a royalty of 17½ cents per ton for coal mined during the first 10 years of the lease and for 20 cents per ton for coal mined during the remainder of the first 20-year period of the lease. The Federal government has the right to reasonably readjust lease terms at the end of each 20-year period on Federal coal leases. The surface of the Federal lease is owned by the Decker Coal Co. (4,989.71 acres), the State of Montana (277.54 acres), the Kendrick Cattle Co. (317.32 acres), George B. Holmes (3,515.37 acres), and the Bureau of Land Management (309.61 acres).

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[3] Coal from the West Decker mine is currently shipped to Commonwealth Edison in Chicago to meet EPA emission standards.

Montana State coal leases have also been issued to the Decker Coal Co. by the Montana Department of State Lands (Appendix A). Two private coal leases have been obtained from Gregg H. and Charles V. Penson and from George B. Holmes. The six State coal leases within or adjacent to the East Decker project area total 1,970 acres (fig. 1). These State leases were sold by competitive bid at auctions held in 1965, 1966, and 1967. State coal-lease rentals are $1.00 per acre for the first 10 years and $5.00 per acre for the eleventh through the twentieth year. The Decker Coal Co. must pay the State of Montana 17½ cents for every ton of coal mined on State lands. After 20 years, the State may readjust rentals, royalties and other lease terms and conditions.

The proposed mine covers an area of about 2,175 acres with an additional 400 acres of plant and associated disturbance. The proposed project area totals 3,715 acres (fig. 3). More than half of the proposed mine area lies on Federal lease Montana 073093 and covers almost a third of the lands included in that lease.

Exploration work began in 1973, and to date, over 1,000 holes have been drilled within the East Decker lease area. An application for a surface-mining permit was submitted to the Montana Department of State Lands, in Helena, Montana, on April 9, 1975, and a mining and reclamation plan was submitted to the Area Mining Supervisor, U.S. Geological Survey, in Billings, Montana, on April 25, 1975.

(3) Location

The East Decker mine area is in Big Horn County, Montana, and includes all or parts of secs. 1, 11, 12, 13, and 14, T. 9 S., R. 40 E. and secs. 7, 8, 17, and 18, T. 9 S., R. 41 E., Montana Principal Meridian (figs. 3 and 23). The proposed mine area lies immediately east of the Tongue River Reservoir and south of Deer Creek, about 2-3 miles east of the existing West Decker mine, and about 5 miles northeast of the Decker Post Office. The project area is approximately 20 miles northeast of Sheridan, Wyoming, the closest community of appreciable size. The present road from Sheridan consists of about 21 miles of paved 2-lane, all-weather road and about 3 miles of graded gravel road to the mine site. The closest community in Montana is Birney, about 24 miles to the northeast. The driving distance to Birney, which is accessible only by graded gravel road, is about 38 miles.

b. Description of the coal

The mine area is underlain all or in part by three separate and distinct coal beds that can be mined by surface methods. They are the Anderson coal, the Dietz 1 coal, and the Dietz 2 coal (figs. 33 and 34). The extent of these beds in the mine area is shown in figure 4.

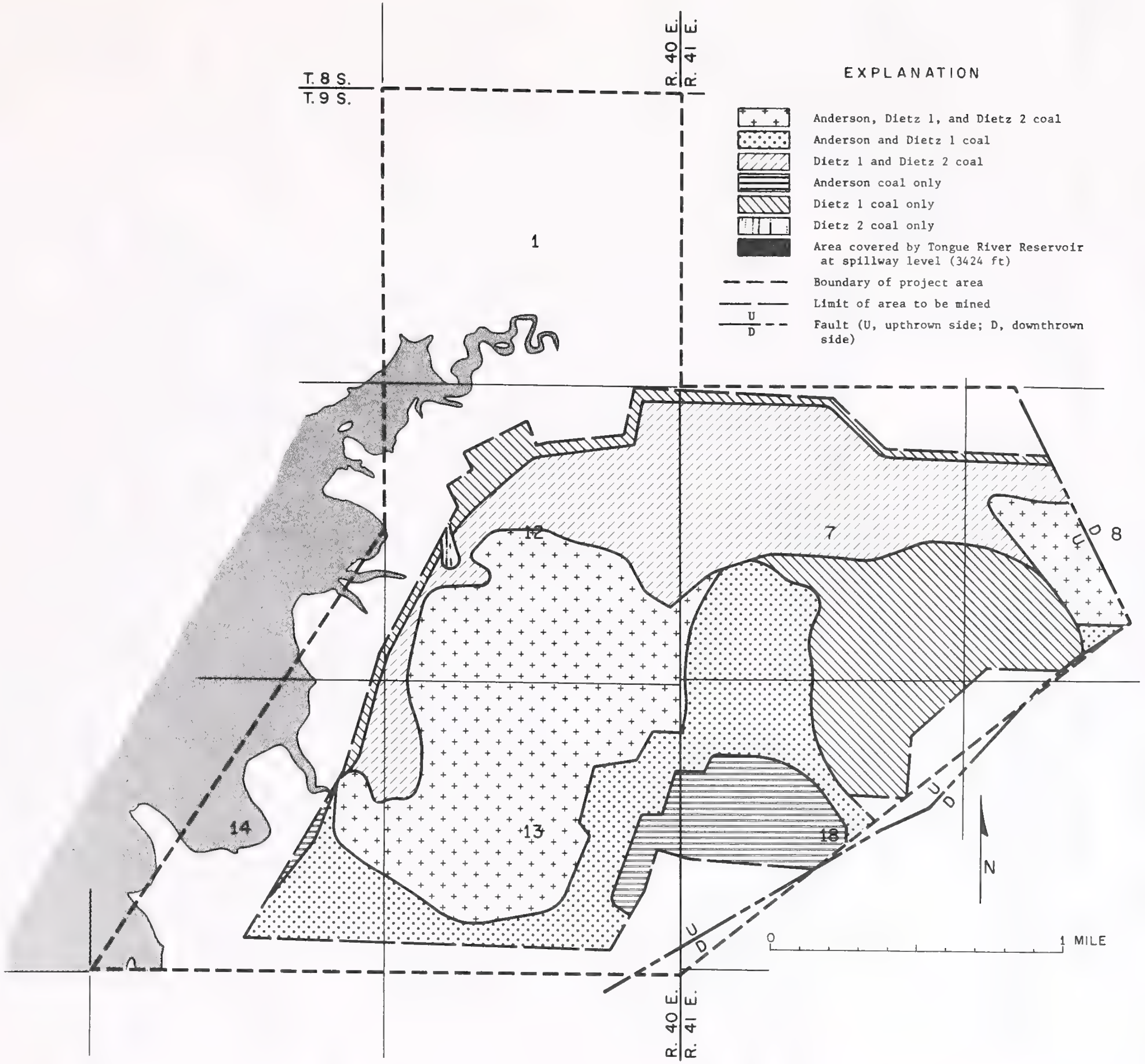
EXPLANATION
Anderson, Dietz 1, and Dietz 2 coal
Anderson and Dietz 1 coal
Dietz 1 and Dietz 2 coal
Anderson coal only
Dietz 1 coal only
Dietz 2 coal only
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of project area
Limit of area to be mined
Fault (U, upthrown side; D, downthrown side)
U
D
T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
1
7
8
12
13
14
18
N
0
1 MILE

Figure 4.—Recoverable coal map for the East Decker area.

The Dietz 2 coal, the lowermost bed, underlies the entire mine area. The Dietz 1 coal, the next higher bed, underlies all of the mine area except about 4 acres near the west margin. The uppermost bed, the Anderson coal, underlies about half of the mine area. The Anderson bed has been removed from the remainder of the area by local burning or erosion. Data on the thickness, area of recoverable coal, and recoverable tonnage for each coal bed, together with the range of overburden and interburden thicknesses, are given in the following table:

Bed	Average thickness (feet)	Recoverable area (acres)	Recoverable tonnage	Range in thickness of overburden and interburden (feet)
Anderson coal	26	1,055	49 million	50-170
Dietz 1 coal	18	1,883	61 million	4-70
Dietz 2 coal	15	1,110	25 million	50-70

The economically recoverable reserves of coal are limited by the depth of overburden. Figure 34 shows a cross section through the mine area depicting the variable overburden and interburden thicknesses. Mine limits are established along the north margin by the limit of merchantable coal[1/] of the Dietz 1 bed and by the channel of Deer Creek; along the west margin by the rail line, access road, and buffer zone along the Tongue River Reservoir; on the south margin by the lease boundary; and on the southeast and east margins by high-angle normal faults. South and east of these faults the coal is buried below current economic recovery limits.

[1/] The limit beyond which the coal has burned or is too oxidized to be used as a fuel.

Coal beds are mildly undulating and locally nearly flat lying within the project area. No faults have been discovered within the area to be mined. The overburden is comprised mainly of clinker formed by the burning of the Anderson coal and of interbedded sandstone, siltstone, and clayey shale capped by a comparatively thin veneer of gravel. The interburden is comprised mainly of sandstone and siltstone with some interbedded shale. The depth of overburden increases progressively southeastward as the land surface rises toward the Badger Hills. Mining would begin in the areas of thinnest overburden and progress in a general southeast direction.

c. Mining sequence

The proposed sequence of mining and the location of every tenth cut is shown in figure 5. The initial box cut would extend in an arc about 20,400 feet long, traversing the north and west margins of the mine area. This initial cut would be excavated to the base of the Dietz 1 coal for a distance of about 17,500 feet, extending along the entire north margin of the mine and southwestward to within about 2,900 feet of the southwest edge of the mine. The remaining 2,900 feet of cut would bottom at the base of the Anderson coal. From this initial cut, the mining front would advance along the inner or concave side of the arc generated by the box cut. The initial spoil would be placed on the outside of the arc formed by the box cut. Spoil from each succeeding cut then would be placed in the mined-out areas. Although the excavated spoil materials would occupy about 25 percent more volume than the inplace rock, the void left by removal of the coal and the shape of the

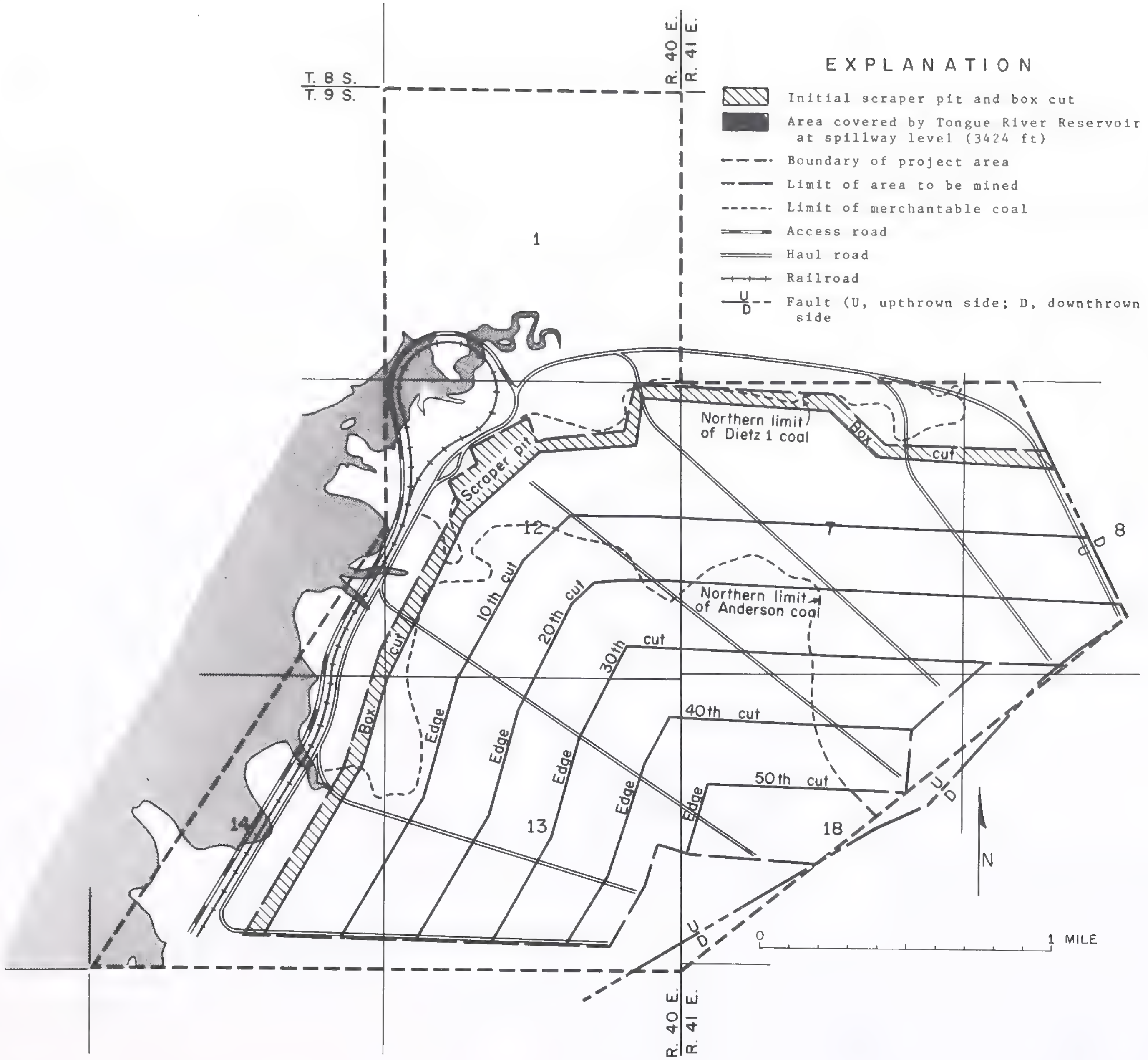
EXPLANATION
▨ Initial scraper pit and box cut
■ Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of project area
Limit of area to be mined
Limit of merchantable coal
Access road
Haul road
Railroad
U D Fault (U, upthrown side; D, downthrown side
T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
1
7
8
12
13
14
18
Scraper pit
Box cut
Northern limit of Dietz 1 coal
Northern limit of Anderson coal
10th cut
20th cut
30th cut
40th cut
50th cut
Edge
U
D
N
0
1 MILE

Figure 5.– Mining sequence and location of roads in the East Decker mine area.

mining advance would always insure sufficient room to place spoils. For example, the length of each successive cut always would be shorter than the preceeding cut as the mining front advances (fig. 5); therefore, the excavated area in each mined-out cut would always be more than the area in the next cut being mined.

Analyses of coal from the East Decker area show that the average Btu contents of the Anderson, Dietz 1, and Dietz 2 beds are 9,430, 9,690, and 9,330 Btu/lb respectively (see table B-4, Appendix 3). Coal from the mine, therefore, must be blended if it is to meet a minimum customer specification of 9,500 Btu. This can be accomplished only by mining two or three beds concurrently.

Prior to excavating the box cut, a scraper pit would be opened in an area of shallow overburden adjacent to the railroad loop and coal-loading area. The overburden from this scraper pit would be used to provide needed fill for the railroad loop and the nearby plant site. Initial coal production would be from this pit. The box cut would be extended southward and eastward from the scraper pit.

d. Mining procedures

(1) Soil material removal and storage

Beginning with the earliest construction and continuing through the life of the mine, topsoil would be removed from all areas adversely affected by construction or by removal of overburden and placement of spoils (fig. 6).

Topsoil removed during the initial stages of mining and construction would be stockpiled. After sufficient areas have been mined, backfilled, and recontoured, topsoil removed in advance of mining would be transported

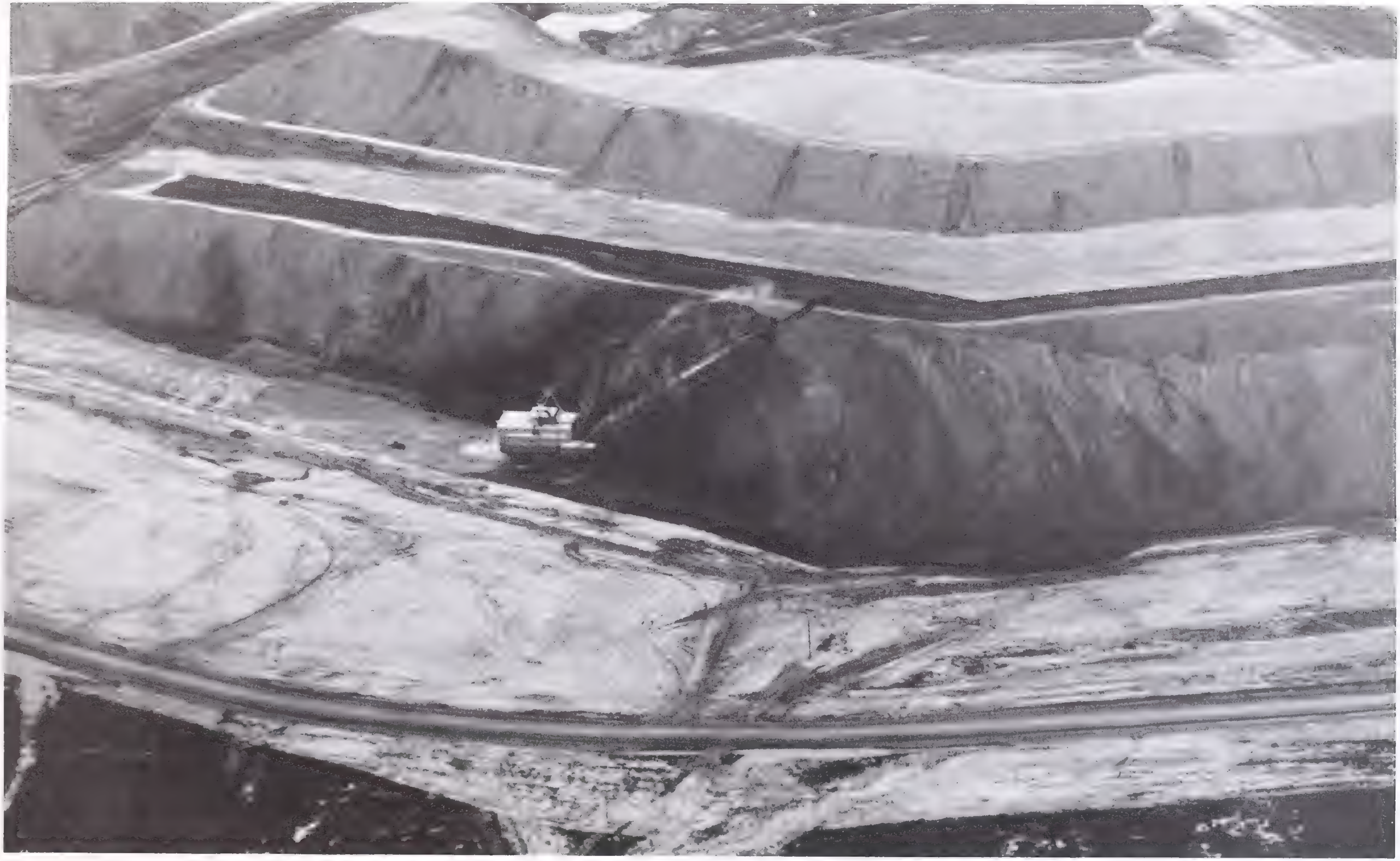

Figure 6.-West Decker mine, June 1975. Dragline is removing overburden and exposing the coal. Soil has been removed from the broad area in the foreground prior to mining. The elongate, dark-colored strip beyond the dragline is reclaimed area on leveled spoils.

and replaced on recontoured spoils in one operation, avoiding insofar as possible the need to stockpile. Detailed soil analyses, including pH, soluble salts, sodium, calcium, magnesium, SAR, saturation percent, and texture (see table B-1, Appendix B), would be made before, during, and after all soil disturbances. Soils would be tested before stripping, after stockpiling, and again after spreading and prior to revegetation.

Two Caterpillar 637[1] push-pull scrapers would be used to remove and replace topsoil (fig. 7). The average depth of topsoil[2] in the mine area is about 1.5 feet.

(2) Overburden and interburden removal

After removal of the topsoil, the overburden must be drilled and blasted before it can be moved by the dragline. Holes drilled with a Bucyrus-Erie 60R drill would be charged with a cast primer attached to primacord and lowered to the bottom of each hole. These holes would then be filled to the desired height with a mixture of prilled ammonium nitrate and fuel oil (ANFO) from a mix-and-load truck. Blasting procedures would be in keeping with all safety regulations. On the average, one blast per day consisting of 50 holes would be required.

The broken overburden initially would be moved by a 70-cubic-yard dragline assembled at the mine site. A second machine of the same size would be assembled on site about a year later. The initial dragline would open a "key" cut to the top of the uppermost coal bed as illustrated in figure 8-A. The machine then would work from atop the leveled spoils from

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[1] Use of trade names is to indicate size of equipment only and does not imply endorsement.

[2] Includes all soil materials in the A, B, and C horizons that are suitable for plant growth; see Glossary for definition of topsoil.

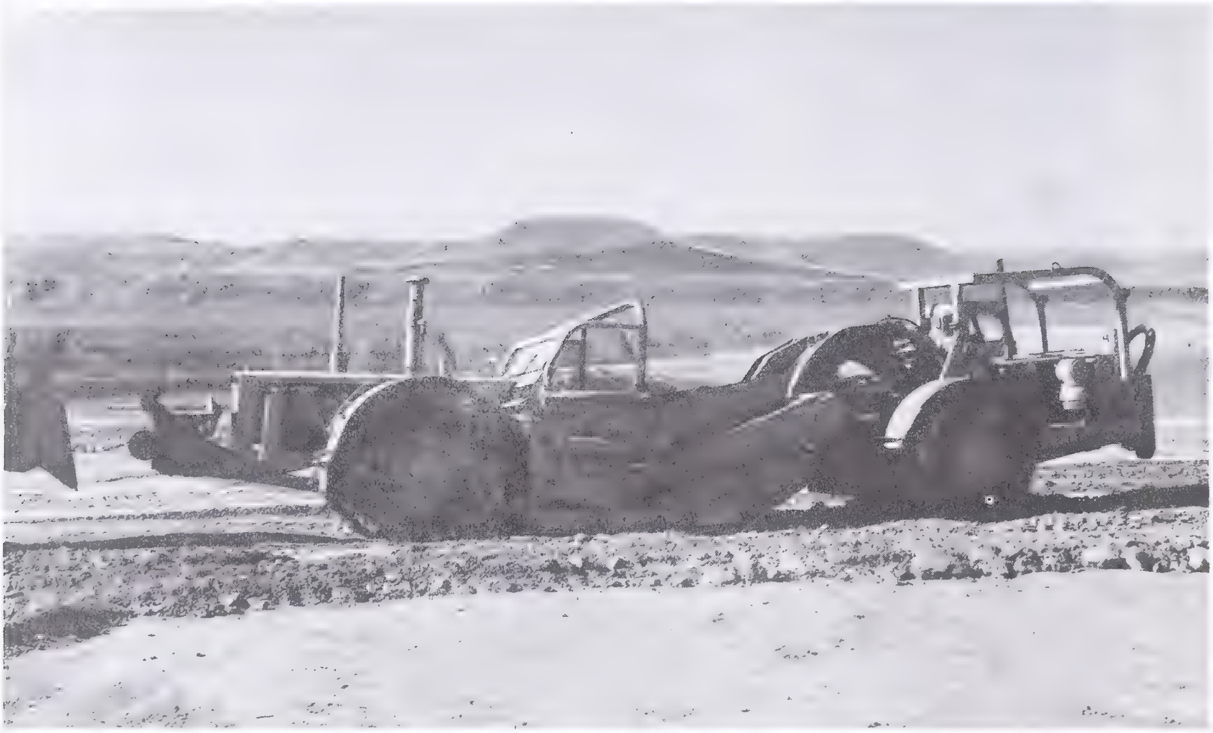
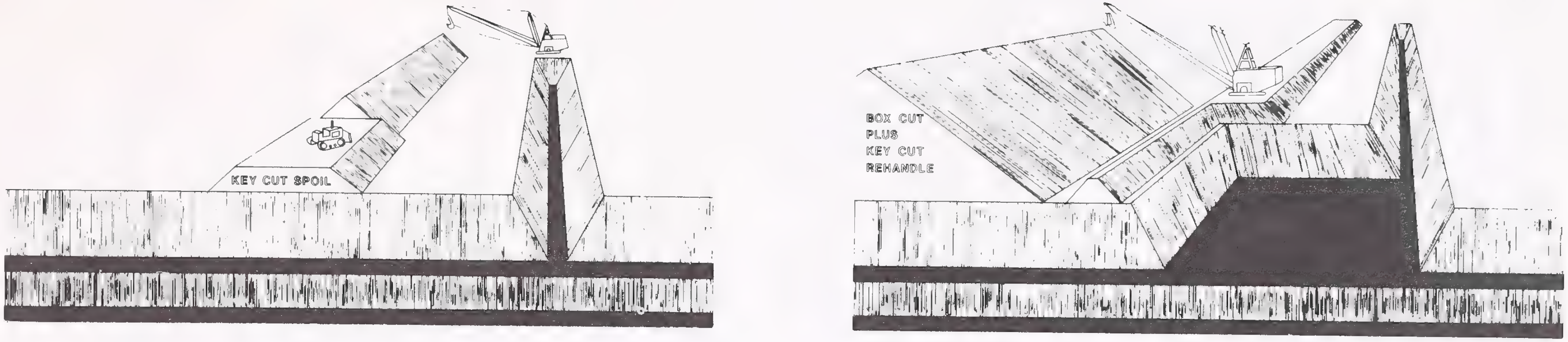
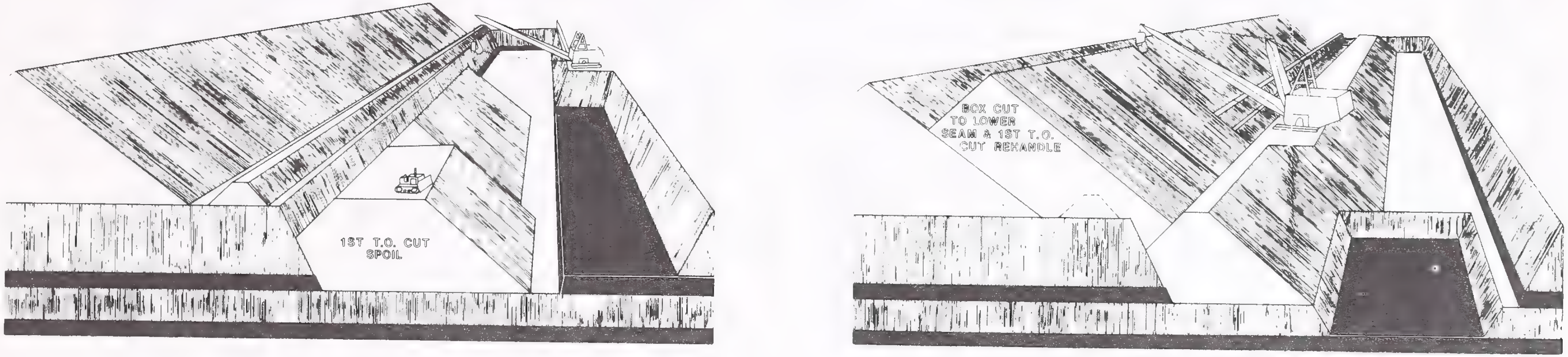


Figure 7.-Push-pull scraper used to remove and replace topsoil and to excavate scraper pits.



A. Key cut

B. Box cut



C. 1st turnover cut

D. Box cut to lower coal

Figure 8.—Procedure for removal of overburden in the East Decker area.

the key cut (fig. 8-B) and dig a wide box cut exposing the coal over the full length of the projected pit as shown in figure 5. The additional height afforded by the leveled spoils from the key cut is necessary to increase the "reach" of the dragline so as to efficiently excavate the box cut. Following removal of the coal from the opened box cut, the dragline would be moved to the opposite side of the cut and would make the first turnover cut (fig. 8-C), placing the spoils in the depression formed by removal of the coal.

After removal of the coal from the first turnover cut, the dragline, working off the leveled spoils from the first turnover cut, would excavate a box cut to the top of the lower coal bed (fig. 8-D).

By using two draglines, one on each side of the cut, two coal beds can be mined concurrently. One machine working from the highwall would remove the overburden exposing the uppermost coal bed. Following removal of the coal, the other machine working from atop the leveled spoils would then remove the interburden, exposing the lower coal for removal. A long pit is essential to provide adequate separation between the two stripping and the two coal-removal operations for safe, efficient operation. Where three beds are to be mined or in areas of excessive overburden, additional passes must be made by the draglines to uncover the coal.

The scraper pit, which encompasses about 30 acres, would be excavated by push-pull-type motor scrapers (fig. 7) in the northwestern corner of the proposed mine area where the uppermost coal bed is closest to the surface (fig. 5). This pit would be adjacent to the truck-dump facilities and on line with the initial box cut. Overburden from the scraper pit would be used as fill in the proposed plant area; the coal would provide an initial supply while the main box cut is being opened. The pit would be backfilled with spoils from the dragline operation.

(3) Coal removal

The coal would be drilled and blasted to facilitate removal and to reduce wear and tear on loading equipment. A Gardner-Denver RD 16C drill would be used to drill vertical holes from the top to the base of the coal. These holes are somewhat smaller in diameter than holes drilled into the overburden and require less explosives. Types of explosives used and blasting procedures would be the same as those used in breaking the overburden. On the average, about 2 blasts per day of 20 holes each would be required.

The coal would be loaded with one 16- and one 30-cubic-yard shovel into 150-ton bottom-dump trucks. A front-end loader would be used as a substitute should one of the shovels require repair.

(4) Reclamation

Reclamation would be coordinated with mining activities and would follow no further than two spoil banks behind the active mining area. The area encompassed by two spoil banks is considered to be the minimum that can be properly leveled to produce the desired surface without interfering with the ongoing mining operations. Backfilling, recontouring of the spoils, and topsoiling would be completed no more than 90 days prior to seeding any portion of the area being reclaimed.

(a) Spoil reclamation

Spoil piles would be leveled and recontoured using D9 Caterpillar tractors. All slopes except the final highwall would be reduced to a 5 to

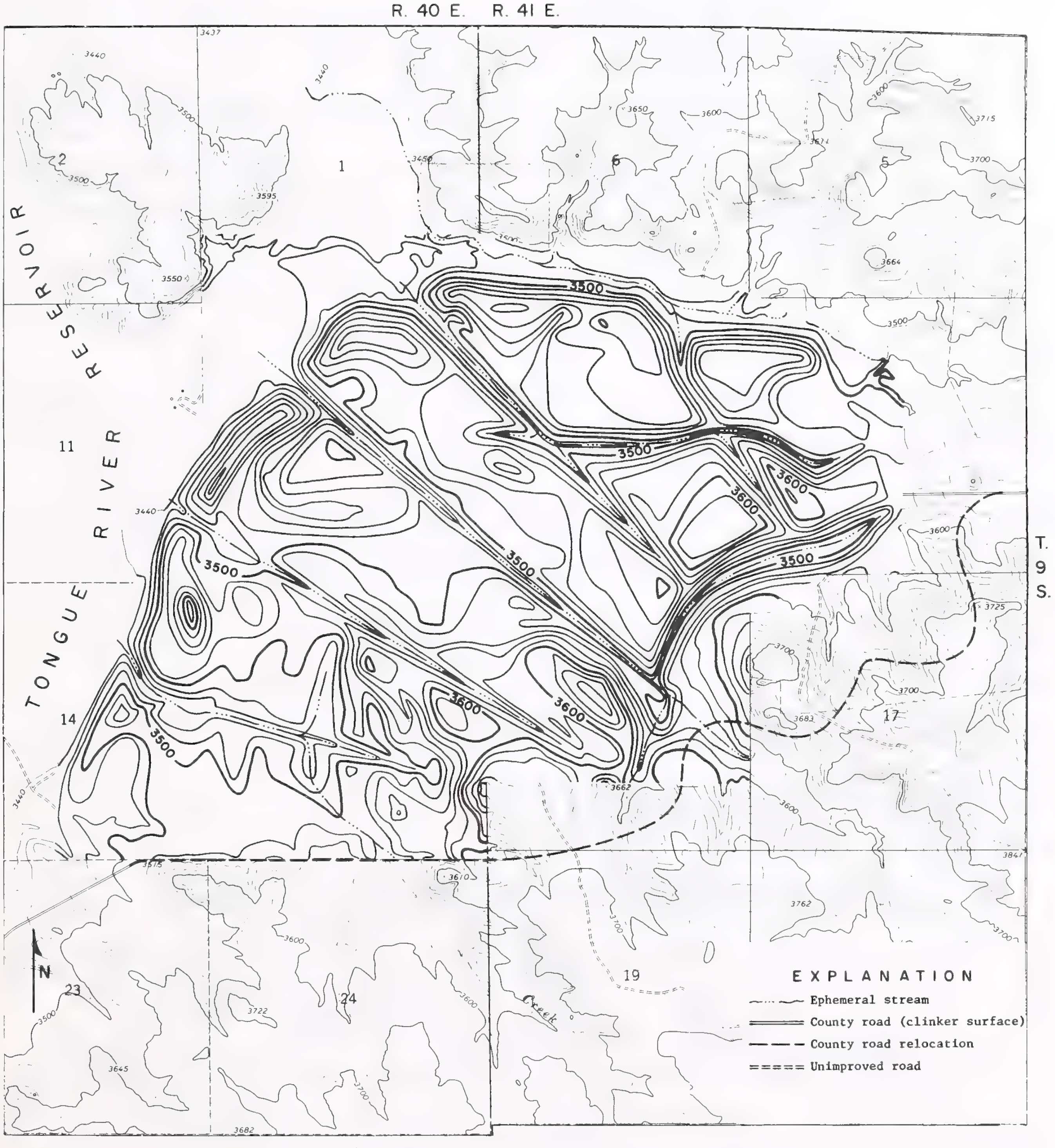
1 (20 percent) or less grade. The final highwall would be reduced to a 20° (36 percent) or less grade. The proposed final topography for the reclaimed mine area is shown in figure 9. The regraded surface, which would generally slope northwestward, would be traversed by west- to northwest-trending linear depressions along abandoned haul roads. These elongate depressions would function as stream valleys carrying surface runoff. The spoil piles left by excavation of the initial box cut along the north and west margins of the mine area would be graded to form a crescent pattern of topographic highs separated by the linear depressions previously described. The regraded topography, although irregular, would not have the same configuration as the original surface. Any spoil material that is not conducive to revegetation would be buried more than 8 feet below the surface of the regraded spoil.

(b) Topsoiling

Topsoil would be placed on the recontoured spoils in one application using push-pull scrapers. The layer of topsoil then would be disced and a seedbed prepared. The topsoil would be obtained either from a topsoil stockpile or directly from areas where topsoil is being removed in preparation for mining. As previously indicated, the process of removal of topsoil in advance of mining and direct replacement on prepared spoils areas would be done in a continuous operation insofar as possible.

(c) Seeding

Seeding of retopsoiled areas would be done with a seed drill using locally grown, genotypical seed, when available. The objective of seeding is to establish a permanent diverse cover of predominantly native species that is capable of regeneration. All seed would be at least 90 percent pure. The following seed mixture is proposed for the East Decker site:



Base from U.S. Geological Survey

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Figure 9.— Proposed topography and drainage after mining in the East Decker area.

Species	Lbs/acre
Western wheatgrass	6
Thickspike wheatgrass	6
Slender wheatgrass	3
Whitmar wheatgrass	1
Green needlegrass	4
Prairie sandreed	2
Blue grama grass	1
Pubescent wheatgrass	1
Smooth bromegrass	1
Yellow sweetclover	½
Slender white prairie clover	½
Four-wing saltbush	1

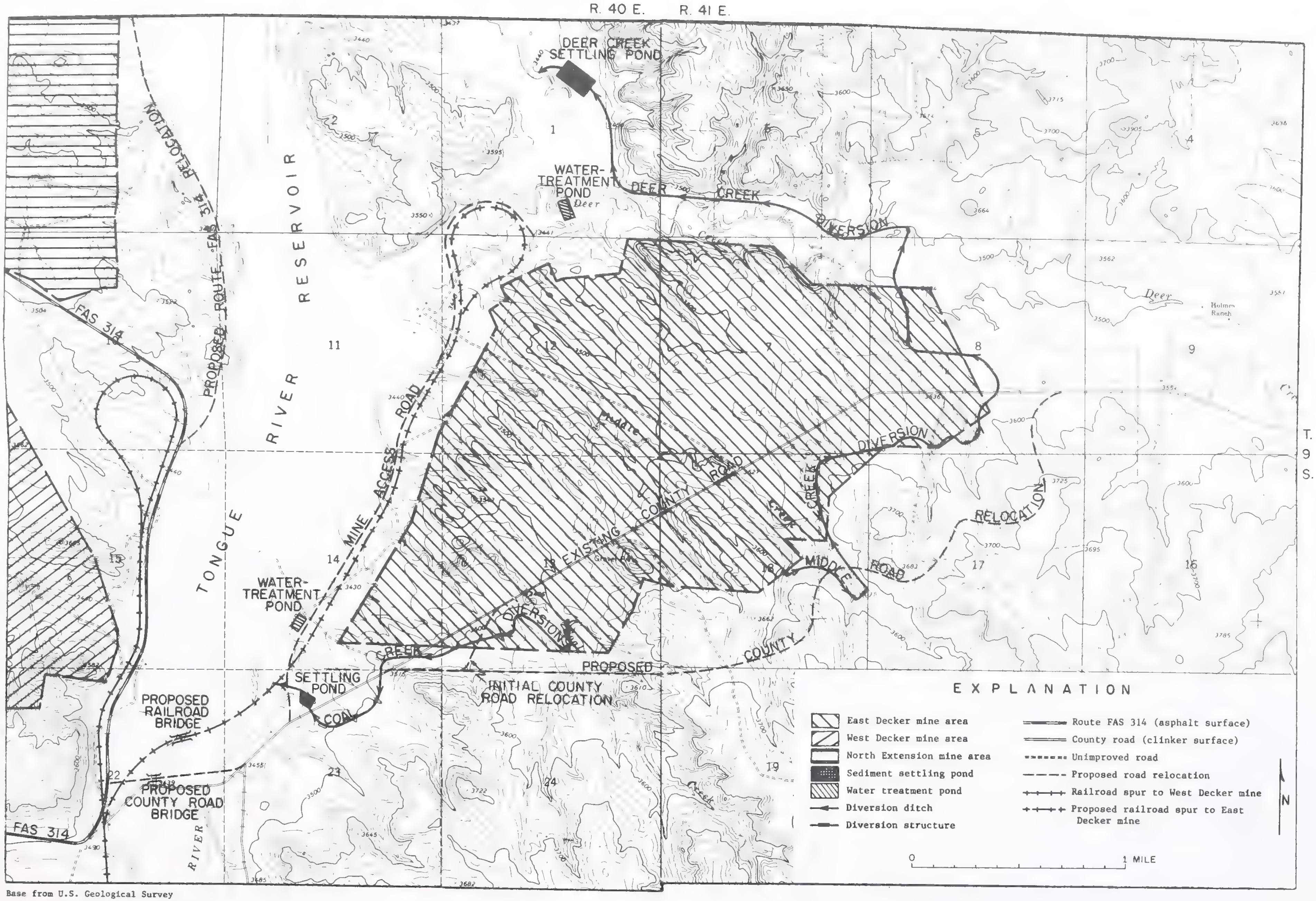
In drainageways, 4 pounds per acre of pure live seed of Tegmar wheatgrass would be substituted for Whitmar wheatgrass. On selected sites in revegetated areas, small amounts of big sagebrush, skunkbush sumac, little bluestem, and sideoats grama may also be planted. The seeded areas would be fertilized using 300 lbs/acre (16-20-0). Mulching and sprinkler irrigation would be used as necessary. Successful seeding generally can be done in both spring and fall. Preferable months are April and October-November. If the first seeding is not satisfactory, additional measures would be taken to insure that an acceptable plant cover is established. A conscientious effort would be made to revegetate all disturbed areas as promptly as possible.

Reclamation work would be monitored continuously by qualified reclamation specialists employed by the company (see section IV. B. 6. e.).

(5) Water diversion and impoundment

The proposed mine area would intersect three principal drainage courses; they are Deer Creek (drainage area 49.1 mi^2), Coal Creek (2.1 mi^2), and Middle Creek (4.5 mi^2) (fig. 24). The drainage area listed is that of the contributing area upstream from the project area. A series of impoundments and diversion channels must be constructed to prevent runoff from these watersheds from entering the mine area. The location of proposed diversion structures and ditches are shown in figure 10. The largest structure would be built across Deer Creek immediately upstream from the mine area to contain flood runoff and to divert all flow out of the present channel into a diversion channel that would parallel the north side of Deer Creek valley. This structure would have little or no initial capacity for water or sediment storage; dimensions are not given in the proposals. The diversion channel would be 10,100 feet long and would discharge into a sediment settling pond (fig. 10) having an initial capacity of about 41 acre-feet. Outflow from the settling pond would be through a concrete-lined spillway equipped with baffle blocks to dissipate energy and prevent local scour. Flow would discharge into an ancient channel of the Tongue River, which in turn would drain northwestward into a bay of the Tongue River Reservoir. The Deer Creek diversion channel has been designed to carry a maximum flow of 7,800 ft^3/s and would be riprapped its entire length to prevent local scour. The first 5,000 feet of channel extending downstream from the point of diversion from Deer Creek would have a slope of 0.001 and would be trapezoidal in cross section, with a width at the bottom of 12 feet, a minimum depth of 23 feet, and sides sloping 1.5:1. The next 5,100 feet of channel would have a slope of 0.002, a width at the bottom of 25 feet, a minimum depth of 15 feet, and sides also sloping 1.5:1.

Smaller structures would be built to intercept and divert runoff from Middle and Coal Creek valleys. Diversion channels would be constructed



Base from U.S. Geological Survey

Figure 10.- Proposed water-diversion system, county road relocations, access road and railroad spur in the East Decker area.

to carry all outflow from these watersheds and to intercept runoff from small peripheral areas that might discharge directly into the mining area (fig. 10). Runoff from Middle Creek and intercepted flow from upland areas to the east would be diverted eastward around the mine area to Deer Creek. Runoff from Coal Creek and from adjacent areas to the west would be diverted along the southwest margin of the mine area and discharged into a sediment settling pond, which in turn would empty into the Tongue River Reservoir. Gradients of these diversion channels would be equal to or less than those of the existing channels.

The Middle Creek diversion dam would be about 107 feet long, about 18 feet high, and would initially impound water to a depth of about 8 feet before spilling to the diversion channel. The channel, in turn, would be 17,000 feet long and designed to carry a maximum flow of 1,800 ft^3/s. The first 7,430 feet of channel downstream from the diversion would have earthen banks and bed on a slope of 0.0015. The tapezoidal-shaped channel typically would be 15 feet wide at the bottom, 10 feet deep, and have sides sloping 1.5:1. The remainder of the channel length, with the exception of two concrete-lined drops, would have earthen banks and bed on a slope of 0.003. The trapezoidal-shaped channel typically would be 12 feet wide at the bottom, 9 feet deep, and have sides sloping 1.5:1. The two concrete-lined drops would be 1,642 feet and 740 feet long on slopes of 0.0275 and 0.04, respectively. Both drops would be trapezoidal in cross section with a bottom width of 7 feet, a depth of 4.5 feet, and sides sloping 1:1.

The Coal Creek diversion dam would be about 320 feet long, about 15 feet high, and would initially impound water to a depth of about 6 feet before spilling to the diversion channel. The channel, in turn, would be 9,500 feet long, would be designed to carry a maximum flow of 1,000 ft^3/s, and would discharge into a sediment settling pond (fig. 10) having a capacity of about 18 acre-feet. Outflow from the settling pond to the Tongue River Reservoir would be through a concrete-lined channel to prevent local erosion. The first 5,000 feet of channel downstream from the diversion would have earthen banks and bed on a slope of 0.0015. The trapezoidal-shaped channel typically would be 12 feet wide at the bottom, 8 feet deep, and have sides sloping 1.5:1. The next 2,250 feet of channel also would have earthen banks and bed, but would be on a slope of 0.003. The trapezoidal-shaped channel typically would be 12 feet wide at the bottom, 6.5 feet deep, and have sides sloping 1.5:1. The remaining length of channel leading to the settling pond would be concrete-lined and would have a slope of .034. This section of channel would also be trapezoidal shaped with a bottom width of 5 feet, a depth of 3 feet, and sides sloping 1:1.

Temporary ditches and impoundments would be constructed within the mine area as needed to prevent storm runoff from interfering with mining operations. Water from these impoundments would be used for dust control or would be pumped into settling ponds before being discharged to the Tongue River Reservoir. Water entering the pit directly from surface runoff and from exposed aquifers would be pumped into settling ponds, one at the southwest corner of the mine area and another just east of the shop-warehouse area (fig. 10).

All water impoundments and diversion channels, except those temporary structures within the mine area, would be designed to withstand an estimated 100-year flood (table 16). All concrete-lined channels would be baffled where they exit into earthen channels, and the transitional area would be riprapped to prevent local scour. Channel areas subject to erosion or sedimentation would be periodically maintained over the life of the mine. Continued observation and testing would enable final channels traversing the reclaimed surface to be designed for hydrologic equilibrium. Settling ponds were designed to emit an effluent that would be of equal or better quality than that of flows discharging to the reservoir through existing channels under similar flow rates.

On conclusion of mining operations and completion of reclamation of spoils areas, all impoundments would be removed and stream flows would be routed through haul-road depressions left in the recontoured surface. Deer Creek would be left permanently relocated through the ancient channel of the Tongue River.

(6) Employment requirements

The number of permanent employees at the mine would vary over the first few years during the construction period. A nonpermanent construction force of about 165 is projected for the first year (starting mid-1976), growing to about 215 for the second year. Production would begin during the third year with a permanent work force of about 200 people. Over the next three years, the permanent force would grow to about 270 people. Construction-related employment would end after the second year.

e. Mining facilities and equipment

The East Decker mine would require on site coal-storage and loading facilities, vehicle-servicing facilities, and a change house. Support facilities, such as offices and heavy-duty repair shops, would utilize current facilities at the West Decker mine.

(1) Roads

(a) County road relocation

The county road, which serves the area east of the Tongue River Reservoir as a farm-to-market route, crosses the southern part of the proposed mine area (fig. 10). Relocation of this road would be accomplished in two phases. Initial relocation would require construction of 0.67 mile of new road to accommodate site preparation and mining activities in the southwestern corner of the mine area during the first 5 to 6 years of operation.

The second phase of the county road relocation would require construction of 4.13 miles of new road south of the mine area (fig. 10). This road would connect with the existing county road east of the proposed mine area and would carry traffic throughout the remainder of the projected mine life. All costs of road relocations would be borne by the Decker Coal Co.

(b) Access road

Access to the East Decker mine would be provided by construction of 3.6 miles of surfaced roadway (fig. 10). This road would cross the existing railroad spur and Montana Federal-Aid Secondary Route 314 (Route FAS 314) at grade about a thousand feet north of the present junction of the county road with Route 314. Westward, the road would provide access to the West Decker shop facilities. Eastward, the road would cross the proposed railroad spur to the East Decker mine at grade and would cross the Tongue River over a new concrete bridge constructed by Decker Coal Co. for Big Horn County immediately north of the existing steel bridge. About a quarter of a mile east of the Tongue River, the access road would intersect and follow the right-of-way of the existing county road for about a quarter of a mile. It then would turn northward, cross the railroad spur to the East Decker mine at grade, and follow along the northwest side of the railroad right-of-way, around the loading loop to the proposed plant area.

The roadway and the concrete bridge over the Tongue River would be constructed so that heavy equipment could be moved empty from the East Decker mine to shops at the West Decker mine for periodic major maintenance. The new bridge and that part of the access road that connects the county road with Route FAS 314 would also serve existing local traffic.

All costs of road design and construction and aquisition of right-of-way would be borne by the Decker Coal Co.

(c) Haul roads

All haul roads would be 50 to 80 feet wide and would be surfaced with crushed clinker from the mine area. Their general location is shown in figure 5. These roads would be extended southeastward across the spoils, roughly perpendicular to the cuts, as mining advances. Ramps would extend downward into the pits. Where multiple beds are being mined, these ramps must be changed after each pass of the dragline. Topsoil would be removed from road areas and stored or used elsewhere before base material is placed. Surface runoff would be controlled by drainage ditches along the sides of the roadway. Haul roads would be maintained with a motor patrol and would be wetted as necessary by a water-spray truck to control dust. Water for dust control would be obtained from impoundments within the mine area and from mine effluent. When use of a haul road is discontinued, the surface material would be removed and reused, if possible; the road and adjacent area then would be shaped, topsoiled, and seeded at the earliest appropriate time.

(2) Railroad

A railroad spur line 4.65 miles long would be constructed from the present Decker Coal Co. line to the plant area at the East Decker mine (fig. 10). Right-of-way would be 500 feet wide, with track and roadbed construction conforming to Burlington Northern Railroad's main-line standards. The spur would cross the Tongue River on a bridge having a ballast deck and constructed of steel girder spans set on concrete piers. Culverts would be used on all ephemeral-stream crossings. The bridge and the culverts would be designed to pass a 100-year flood. Riprap or flared end sections would be provided at both inlet and outlets of culverts to minimize erosion.

The rail spur would end in a broad loop (figs. 10 and 11) that would facilitate rapid loading of an estimated 13 unit trains per week (100 cars, each carrying 100 tons of coal). Zero percent grade would be maintained around the loop and for 6,000 feet south along the spur. The remainder of the spur would have a maximum grade of 1 percent, which would be compensated for at the rate of 0.04 percent per degree of curve. The maximum curvature would be 3 degrees, except for the loading loop, which would have a curvature of 6 degrees. A short length of track on the east side of the loop would be used to unload materials and supplies. A somewhat longer track on the west side of the loop (fig. 11) would be used to deliver materials to the dragline erection site.

(3) Power

Electric power for the mine would be furnished by Pacific Power and Light Co., which currently provides service to the existing West Decker mine. A 34.5 kv powerline would be constructed from a substation south of

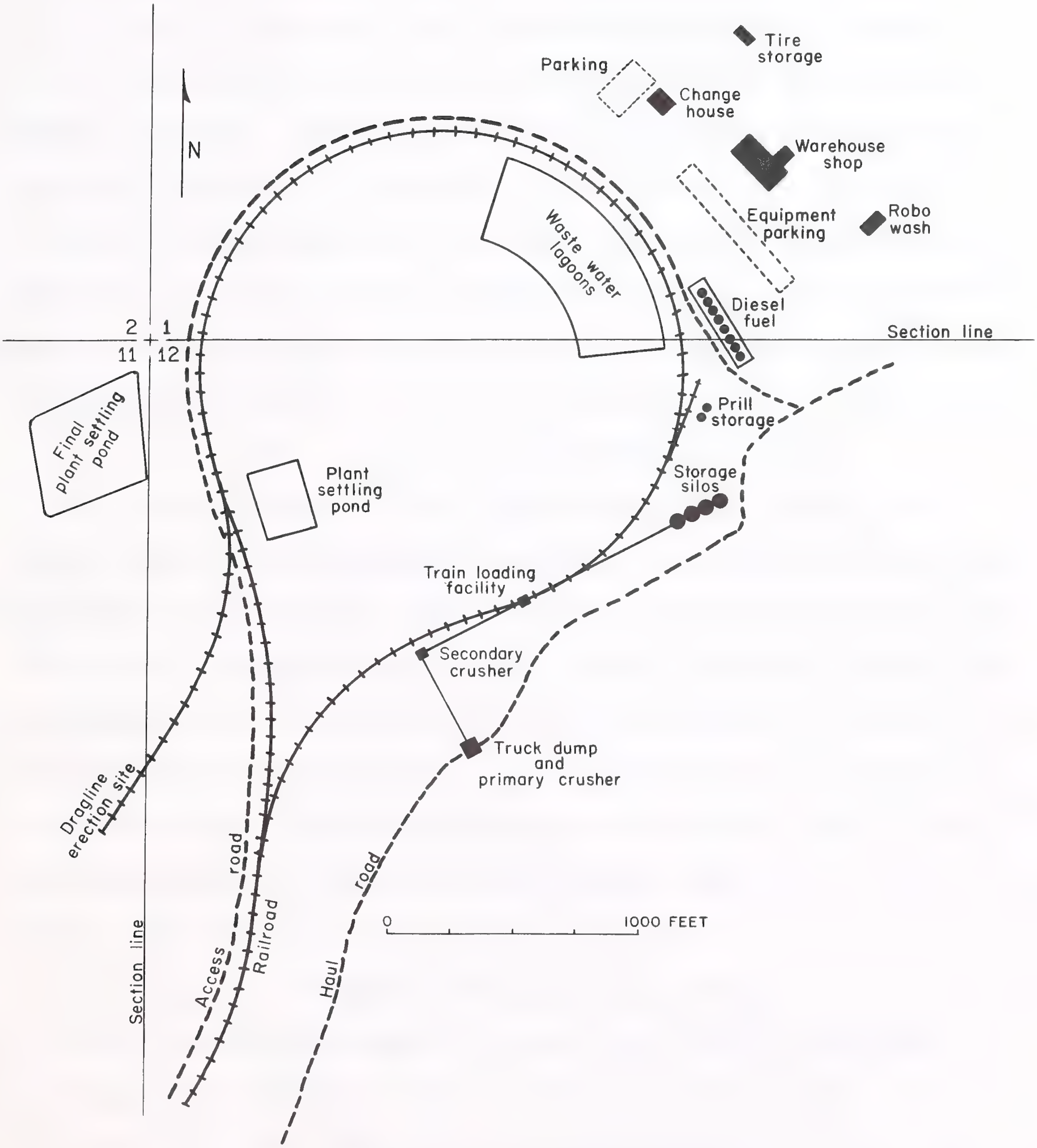


Figure 11 .--Proposed plant area for the East Decker mine.

the West Decker mine along the road-railroad corridor to the plant site of the East Decker mine. That line would be extended around the periphery of the proposed mine area and would reconnect with the incoming line at the southwest corner. Stub lines would be run from this main line to the pit area where portable transformers would be used to reduce voltage as required. Flexible cables would be used to distribute power from the transformers to the equipment. An existing REA powerline which crosses the mine area would be relocated south and east of the mine. All powerlines would conform to REA standards for protection of birds against electrocution. Power consumption is estimated to be about 37 million kwh per year for the East Decker mine.

(4) Structures

Major structures at the mine, other than coal processing facilities, would be a shop-warehouse building and a change house, both of which would be rigid-frame, prefabricated, steel buildings. In addition, two smaller semi-enclosed structures, a wash building for equipment and a tire storage shed, would be constructed. A chain link fence would be used to control access to the plant area and to enclose a storage yard behind the shop warehouse. High use areas requiring night illumination would be lighted with mercury vapor lamps. The location of structures described above is shown in figure 11.

(5) Fuel and explosives storage

Diesel fuel for mobile equipment and for use with ammonium nitrate prills (1.3 million gallons annually) would be delivered in rail cars and stored in eight 1,500-gallon, above-ground tanks (fig. 11). Gasoline would be delivered by truck and stored in underground tanks located south of the change house. Annual consumption is estimated to be 125,000 gallons. Class A explosives (dynamite, precast primers, and primacord) would be stored in type 2 skid-mounted facilities that can be moved as required. Class C explosives (nitrocarbonitrate) would be stored in separate but adjacent facilities. All facilities for the storage of explosives would meet standards established by 26 C.F.R. 181.

Ammonium nitrate prills are not classed as explosives until a sensitizing agent such as fuel oil is added. These prills would be stored in silos adjacent to the siding on the east side of the railroad loop. Annual consumption is estimated to be 12.2 million pounds.

(6) Coal processing and storage facilities

Coal would be transported from the pit area by bottom-dump coal haulers and unloaded at the truck dump where a gravity feed would lead to the primary crushers. Output from the primary crushers would then be transported by elevated conveyor to a secondary crusher where the coal would be reduced to minus 2-inch size. Another elevated conveyor would transport the crushed coal to the loading facility. Coal could be loaded directly into railroad cars at this point or transported to storage. The storage facility would include four above-ground concrete silos, each having a capacity of 15,000 tons of coal. A return conveyor at the bottom of each silo would be used to move coal back to the loading facility. These silos would stand on steel pilings set flush with the land surface and would be 190 feet high.

(7) Water supplies and waste disposal

Total water consumption is estimated to be about 60,000 gal/day. About 53,000 gal/day would be used for dust control, for washing equipment, and for fire control. The remaining 7,000 gal/day would be used for human consumption and for sanitary facilities. Water for dust control, about 45,000[1] gal/day, would be obtained from mine effluent. The balance of about 15,000 gal/day (about 10 gal/min) would be obtained from one of the existing wells near the plant site (fig. 43). Water from this well would be stored in a 200,000-gallon tank located near the plant site.

Waste water from the plant would be wholly contained in clay-lined lagoons located inside the loading loop (fig. 11). The clay for lining the lagoons would come from commercial sources at Kaycee, Wyoming. These lagoons would be located on compacted materials used to fill the old channel of Deer Creek within the railroad loop (fig. 10) and would be constructed so as to prevent, insofar as possible, discharge into surface or subsurface waters. Total surface area of the lagoons would be about 5 acres, which should be more than adequate to evaporate the estimated volume of 2.4 million gallons of water annually. The evaporation rate in the Decker area is about 28 inches per year.

(8) Mining and reclamation equipment

A list of the major equipment that would be used in the mining and reclamation work is given below. In addition, miscellaneous support equipment such as pickups, cranes, mechanic trucks, fuel and lubrication trucks, and shop equipment would be used.

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[1] Estimated use of water for dust control was increased from 45,000 gallons to 80,000 gal/day when air-quality monitoring in 1976 in conjunction with mining at the West Decker mine indicated that more extensive dust-control measures would be necessary than originally planned (Jack Reed, Decker Coal Co., oral communication).

Major equipment

Number	Size[1]	Description
2	Bucyrus Erie	70-yard dragline
1	Bucyrus Erie	16-yard shovel
1	Bucyrus Erie	30-yard shovel
1	Gardner Denver	RD 16C drill
1	Bucyrus Erie	60R drill
6	Wabco	150-ton bottom-dump truck
2	Caterpillar 637	scrapers
1	Dart	26-yard front-end loader
2	Caterpillar D9	bulldozer
1		water truck

[1] Trade names are used to indicate size of equipment and do not necessarily denote equipment purchased.

The use of some special equipment not fully utilized by one mine would be shared with the West Decker and North Extension mines. However, sufficent equipment would be obtained to insure efficient operation of all three mines.

3. North Extension mine proposal

The proposal described in this section is the mining plan for existing leaseholds of the Decker Coal Co. in the North Extension area and does not include mining on adjacent lands lying between the Company's existing lease boundaries and the Tongue River Reservoir in sec. 34, T. 8 S., R. 40 E., and in the E½ sec. 3, T. 9 S., R. 40 E. (fig. 1). The Bureau of Land Management tentatively expects to hold a competitive coal-lease sale for federally-owned coal in sections 3 and 34 in May, 1977, or as soon thereafter as administrative procedures allow. If these leases are obtained by the Company and can be coordinated with the approval of the mining plan, the mining sequence in the North Extension area will be modified accordingly. A discussion of this possible change in the plan is presented in section VIII. F.

It should be noted that the Decker Coal Co. currently holds valid coal leases for all lands included in the following proposal. As such, the Company has a lease right to mine the lands described in those leases, subject to Federal and State approval of the proposal mining and reclamation plans and the administrative alternatives described in sections VIII. B. and C. Should the Company for any reason not obtain a coal lease for those adjacent lands in sections 3 and 34, they retain the full right to develop their existing leaseholds in the North Extension area.

a. Background

(1) Purpose

The Decker Coal Co. proposes to open and operate a major expansion of their existing West Decker operations about half a mile north of the present West Decker mine in the North Extension area (fig. 3). Although this proposed operation would use existing plant and loading facilities at the West Decker mine, it represents an enlargement of total operations using additional men and equipment. For purposes of this study, therefore, it is regarded as a new and additional mine in the area. Approximately 47 million tons of coal would be recovered in the area extending westward from Tongue River Reservoir to about half a mile west of Route FAS 314. The mine would operate for about 20 years with an annual production rate of about 2.3 million tons per year. Coal would be shipped by unit train to Detroit, Michigan (Detroit Edison) where it would be used for electrical power generation. The average heating value of the coal is about 9,500 Btu; the sulfur content is about 0.38 percent.

(2) History

The proposed North Extension mine is located largely on three Federal coal leases held by Decker Coal Co. They are Montana 057934, Montana 057934-A, and Montana 061685 (fig. 1 and Appendix A). The first of these, Montana 057934, was issued on October 1, 1963; Montana 061685 was issued on March 1, 1964. Some of the lands included in the first lease, however, were reassigned on October 1, 1971, under lease Montana 057934-A. No State coal leases exist within the proposed North Extension mine area.

The West Decker mine is currently operating on portions of Federal leases Montana 057934-A and Montana 061685 and on State of Montana coal lease C-527-63. The Federal leases provide for a royalty of 15 cents per ton of coal mined; the State lease provides for a royalty of 17½ cents per ton of coal mined. A small surface coal mine called the Tongue River mine covers parts of two 40-acre tracts within the proposed North Extension area (fig. 1). Coal from this mine, which operated intermittently from 1954 to 1970, has been used largely by residents in the area for heating and cooking. Total production has been about 35,000 tons. The northernmost tract in the SE¼NW¼ sec. 33, T. 8 S., R. 40 E., is on Federal coal lease Montana 06770 held by Glenn Mock. It would be included in the North Extension mine through an operating agreement between Mock and the Decker Coal Co. The adjacent tract to the south is on fee coal owned by Rosebud Coal Sales Co. and would also be included in the proposed mine.

Exploration began in the North Extension area in 1968, and to date, about 800 test holes have been drilled and logged. An application for a surface-mining permit was submitted to the Montana Department of State Lands in Helena, Montana, on May 19, 1975; and a mining reclamation plan was submitted to the Area Mining Supervisor, U.S. Geological Survey in Billings, Montana, on May 28, 1975. The proposed mine covers an area of about 1,340 acres; the proposed project area covers an area of about 2,325 acres (fig. 12).

(3) Location

The North Extension area is in secs. 33 and 34, T. 8 S., R. 40 E. and secs. 3, 4, 9, and 10, T. 9 S., R. 40 E., Montana Principal Meridian, Big Horn County, Montana. The area is directly north of the West Decker mine and west of the Tongue River Reservoir. Montana Route FAS 314 crosses the west side of the mine area. The outline of the proposed mine area is shown in figure 3.

b. Description of the coal

The North Extension area is underlain by two coal beds that can be mined by surface methods. The upper bed is the Anderson-Dietz 1 coal combined, which is the bed currently being removed at the West Decker mine. The lower bed is the Dietz 2 coal, which underlies the entire area. The merchantable coal limit of the Anderson-Dietz 1 bed--limit beyond which the coal is burned or is too oxidized to be used as fuel--is shown in figure 12. Relevant data for the coal beds are given in the following table:

Bed	Average thickness (feet)	Acreage	Recoverable tonnage	Range in thickness of overburden (feet)
Anderson-Dietz 1 coal	5-50	617	14 million	5-130
Dietz 2 coal	17	1,340	33 million	25-150

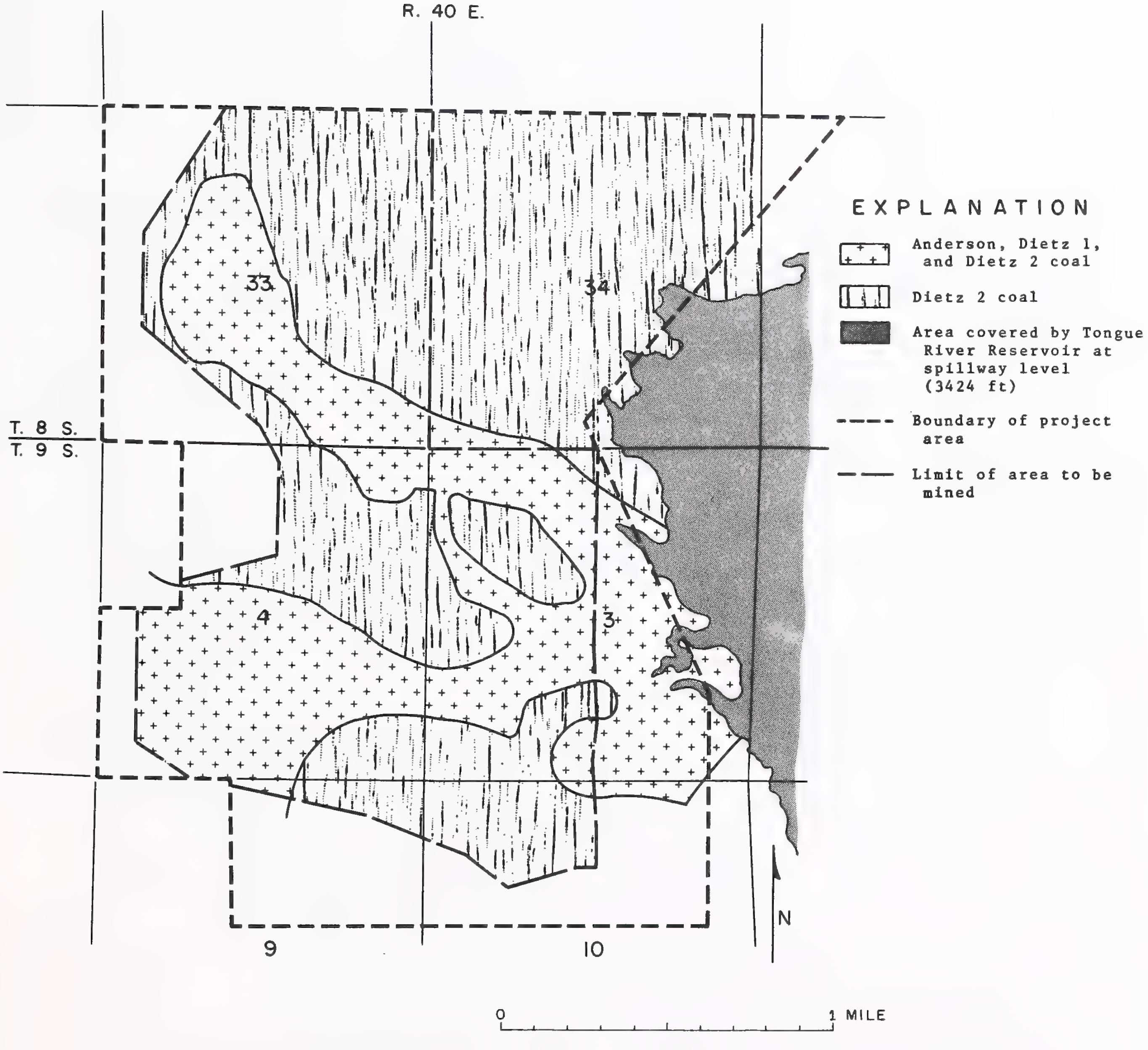

R. 40 E.
T. 8 S.
T. 9 S.
33
34
4
3
9
10
N
0
1 MILE
EXPLANATION
Anderson, Dietz 1, and Dietz 2 coal
Dietz 2 coal
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of project area
Limit of area to be mined

Figure 12.— Recoverable coal map for the North Extension area.

The great variation in the thickness of the Anderson-Dietz 1 coal is largely a result of local burning. This bed has been partially or completely burned over most of the proposed mine area.

The major portion of recoverable coal would be obtained from the lowland areas along the broad lower reaches of Spring and Pearson Creeks. The mine would extend to the north and east boundaries of the lease area. The western limits of mining would be controlled by the rapid increase in the thickness of the overburden as the valleys of Spring and Pearson Creeks narrow and are bounded by steep side slopes. Southward the increasing thickness of overburden also limits recovery of the lower or Dietz 2 bed.

Much of the overburden is clinker formed by burning of the Anderson-Dietz 1 coal, but alluvium locally overlies the clinker in the bottoms of the larger stream valleys. Shale interbedded with sandstone lenses form the interburden between the Anderson-Dietz 1 and the Dietz 2 coal beds. Figure 34 shows a typical cross section through the proposed mine area.

c. Mining sequence

As shown in figure 13, mining would start at the east boundary of the lease and progress westward. The east-trending township line between sections 3 and 34 would divide the mining front into two separate north-trending cuts. The north cut would be a mile long, would start at the east line of section 33, and would progress westward up Spring Creek valley. The south cut would be about 1¼ miles long, would start at the middle of section 3, and would progress westward up Pearson Creek valley. The mining advance on both cuts would be independent and would be controlled in part by the quality of the coal, which must be blended to obtain an average

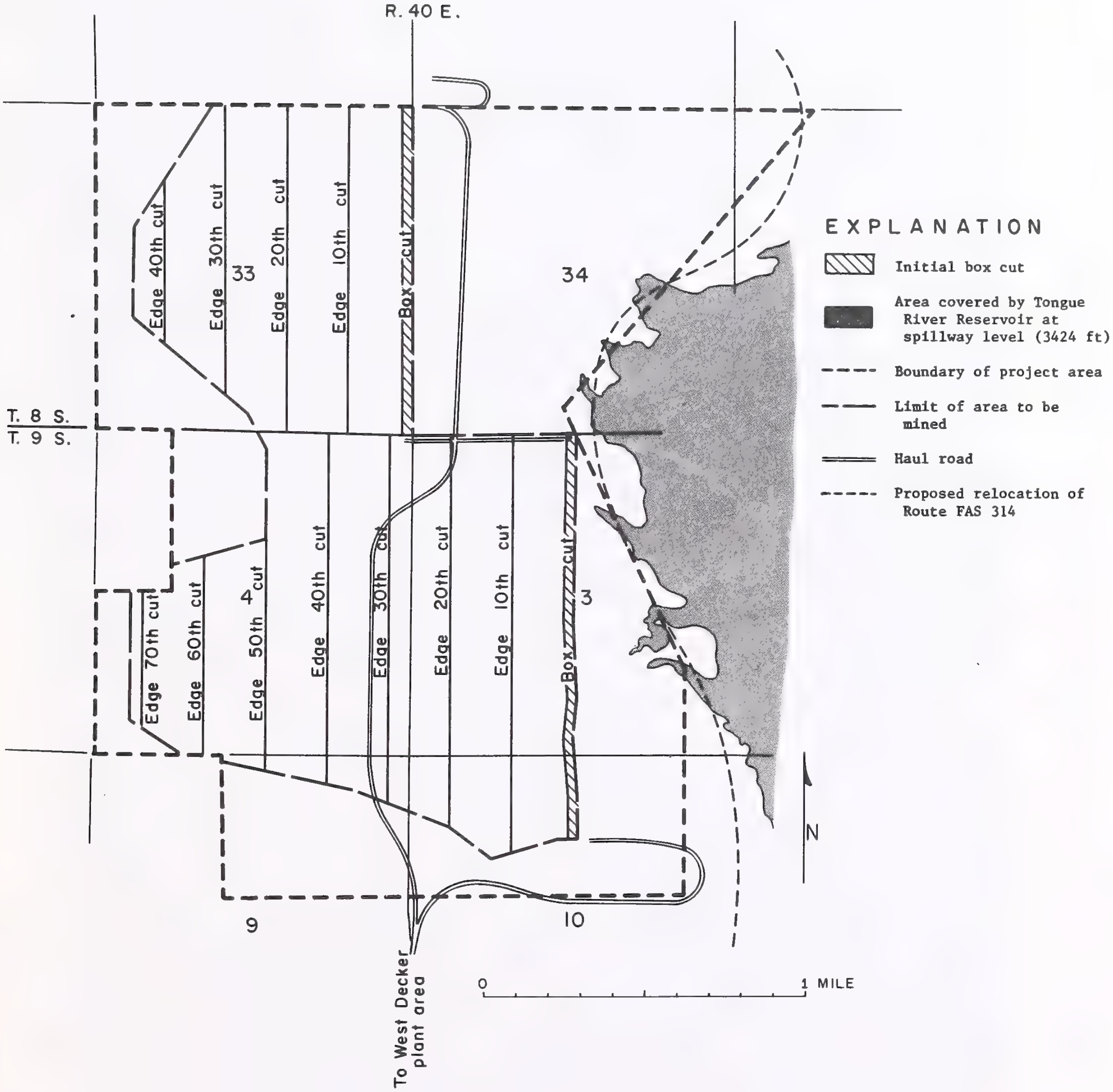


Figure 13.— Mining sequence and location of roads in the North Extension area.

heating value of 9,500 Btu/lb to meet customer requirements. Length of the cuts would decrease westward as the valleys of Spring and Pearson Creeks narrow and the depth of overburden along the valley sides becomes excessive.

Initial box cuts would be made to the coal such that the east margin of each cut coincides with the east margin of the lease. Spoils would be placed east of the cuts off the lease except in the W½NE¼ sec. 3 where Decker Coal Co. does not own the surface. Spoils in that area must be placed west of the cut and subsequently rehandled in succeeding cuts, each of which would be about 100 feet wide. The two pits would not be connected at the bottom; however, ramps and interconnecting roads would allow equipment to move from the surface into each pit and from one pit to the other.

d. Mining procedures

(1) Soil material removal and storage

The same procedures used at the East Decker mine would be used at the North Extension mine (p. 31).

(2) Overburden and interburden removal

A single 41-cubic-yard dragline would be used to strip the overburden and expose the coal (fig. 14). Most of the overburden in this area is clinker, which is generally highly fractured and should not require blasting prior to removal with the dragline. Where the overburden and (or) interburden must be blasted, the same procedures would be followed as those described in the East Decker proposal (p. 32).

The overburden removal procedure is shown in figure 15. On the first pass the dragline (fig. 16) would work from the east side to make the initial box cut exposing the uppermost coal (fig. 15-A). After removal of

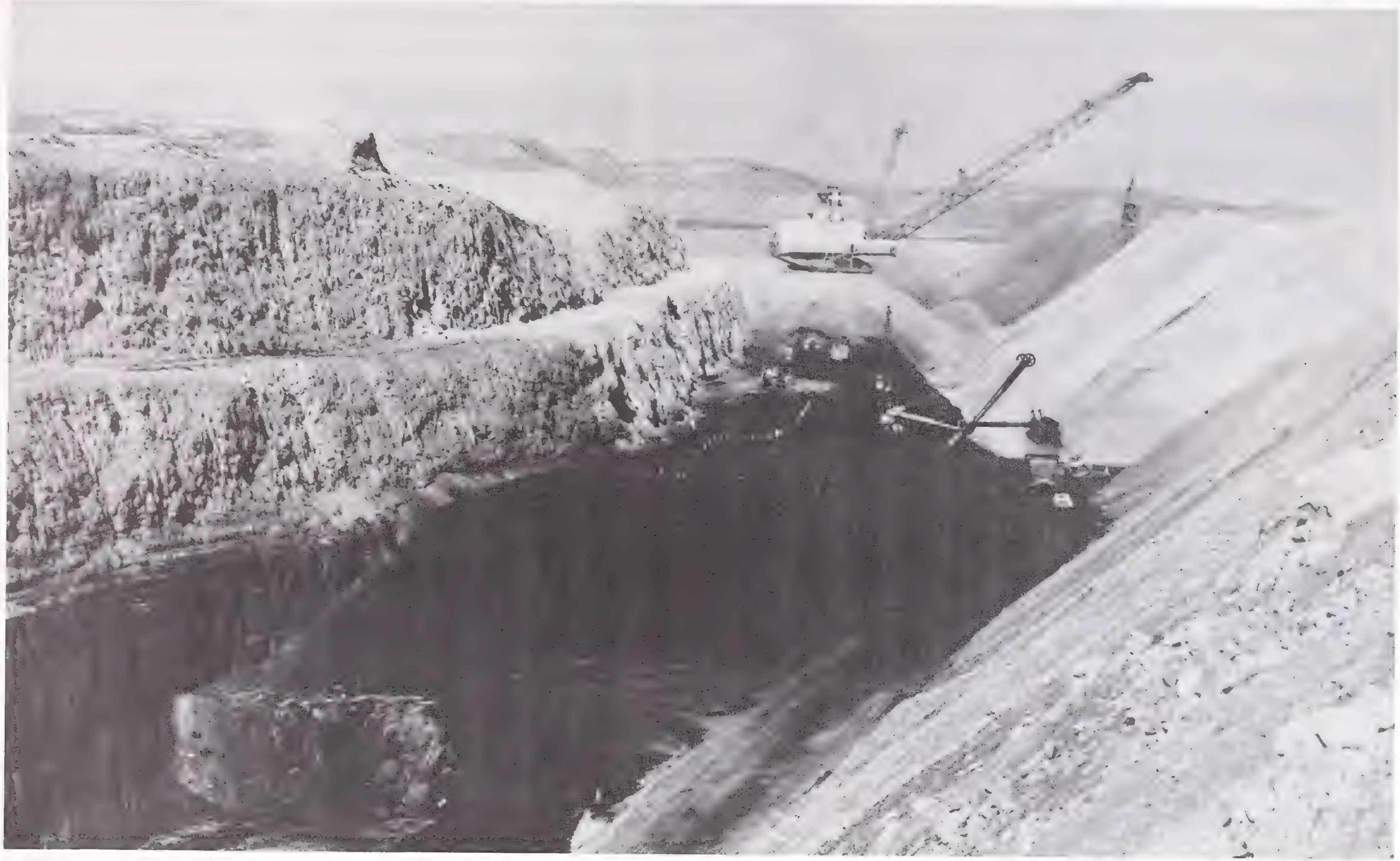
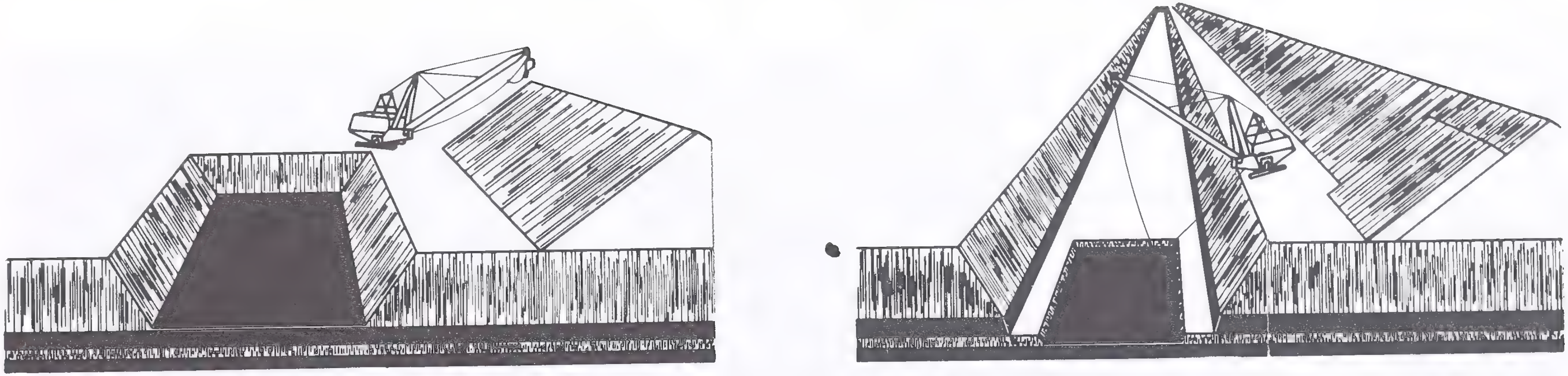
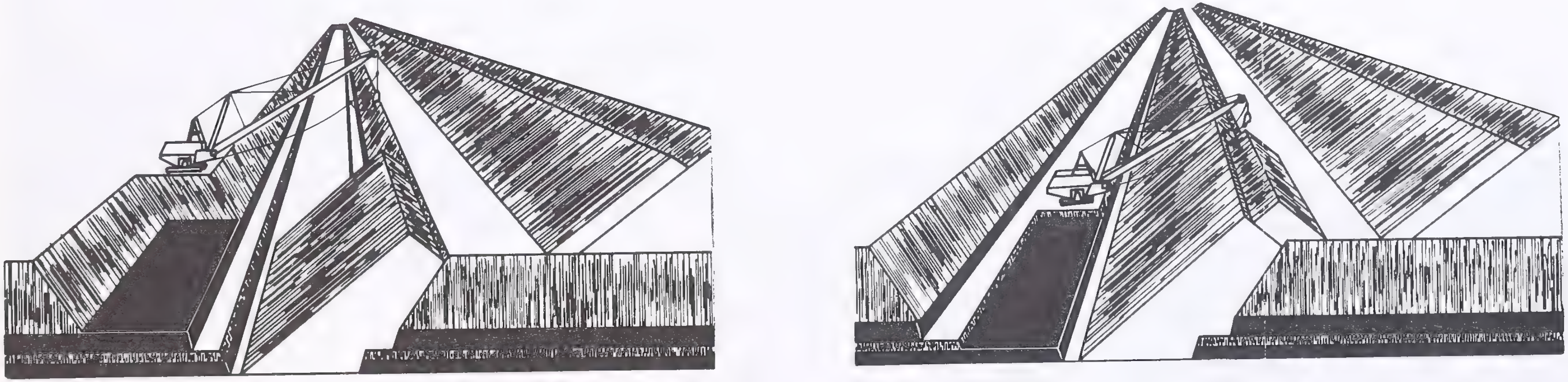


Figure 14.-West Decker mine, August 1975. Typical turnover cut; the dragline is used to expose the coal, which is then loaded into trucks and hauled to the loading area (fig. 2).



A. Box cut to Anderson-Dietz 1 coal bed

B. Box cut to Dietz 2 coal bed



C. Turnover cut to Anderson-Dietz 1 coal bed

D. Turnover cut to Dietz 2 coal bed

Figure 15.– Procedure for removal of overburden in the North Extension area.

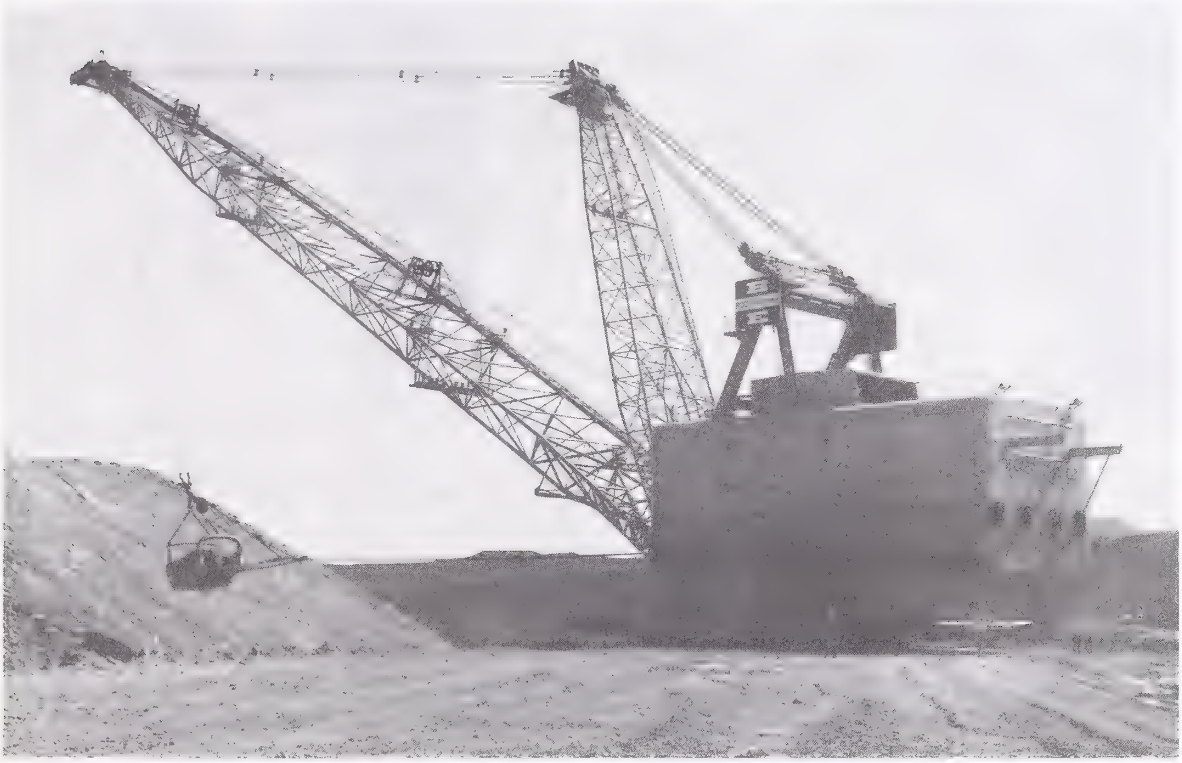


Figure 16.-41-yard dragline currently used at the West Decker mine. This machine would be moved to the North Extension mine and replaced with a 70-yard dragline.

the coal, a second pass would be made in the same manner exposing the Dietz 2 coal (fig. 25-B). Succeeding turnover cuts would be made with the dragline positioned on the west side of the pit. The thin overburden in this area can be removed with a single pass of the dragline (fig. 15-C). Where the upper coal is not entirely burned and two beds are to be mined, the dragline would work from the top of the interburden to strip that material off the lower coal (fig. 15-D).

A modified method of overburden removal would be used in that length of cut where spoils from the box cut cannot be placed east of the pit. Figure 17 illustrates this procedure, which effectively increases the depth of overburden that must be rehandled by the dragline in making the first few turnover cuts. Thereafter, the procedure would be the same as that shown in figures 15-C and 15-D.

(3) Coal removal

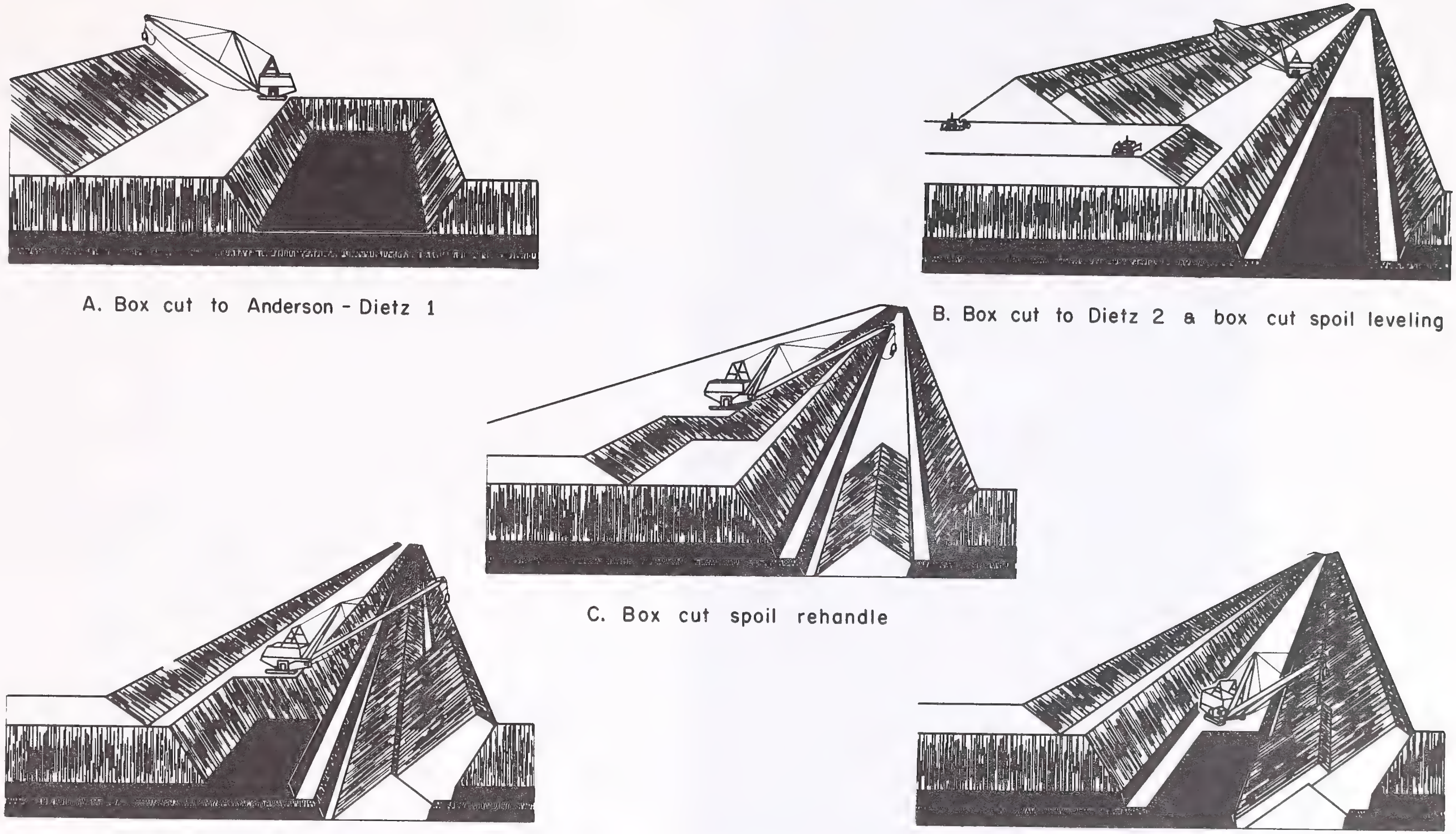
Coal would be drilled and blasted to facilitate loading as described in the East Decker proposal. A 16-cubic-yard shovel (fig. 18) would load the coal into 150-ton bottom-dump trucks, which would haul the coal to the present truck dump at the West Decker mine. A front-end loader would be used as a substitute should the shovel require repair.

(4) Reclamation

Reclamation procedures to be followed in the North Extension area would be the same as those described previously for the East Decker area (p. 37).

(a) Spoil reclamation

Spoil materials would be recontoured with bulldozers into a landform that would approximately conform to the topography shown in figure 19.



A. Box cut to Anderson - Dietz 1

B. Box cut to Dietz 2 & box cut spoil leveling

C. Box cut spoil rehandle

D. Turnover cut to Anderson - Dietz 1

E. Turnover cut to Dietz 2

Figure 17.– Alternate procedure for removal of overburden in the North Extension area.

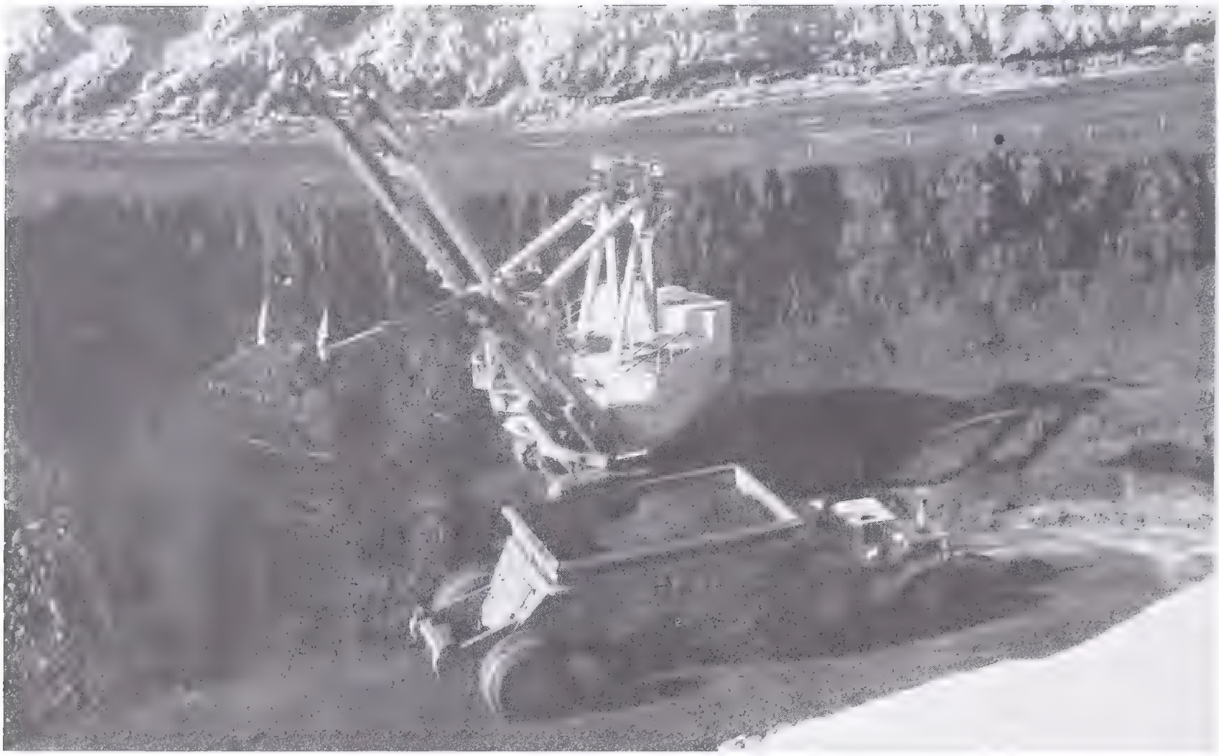
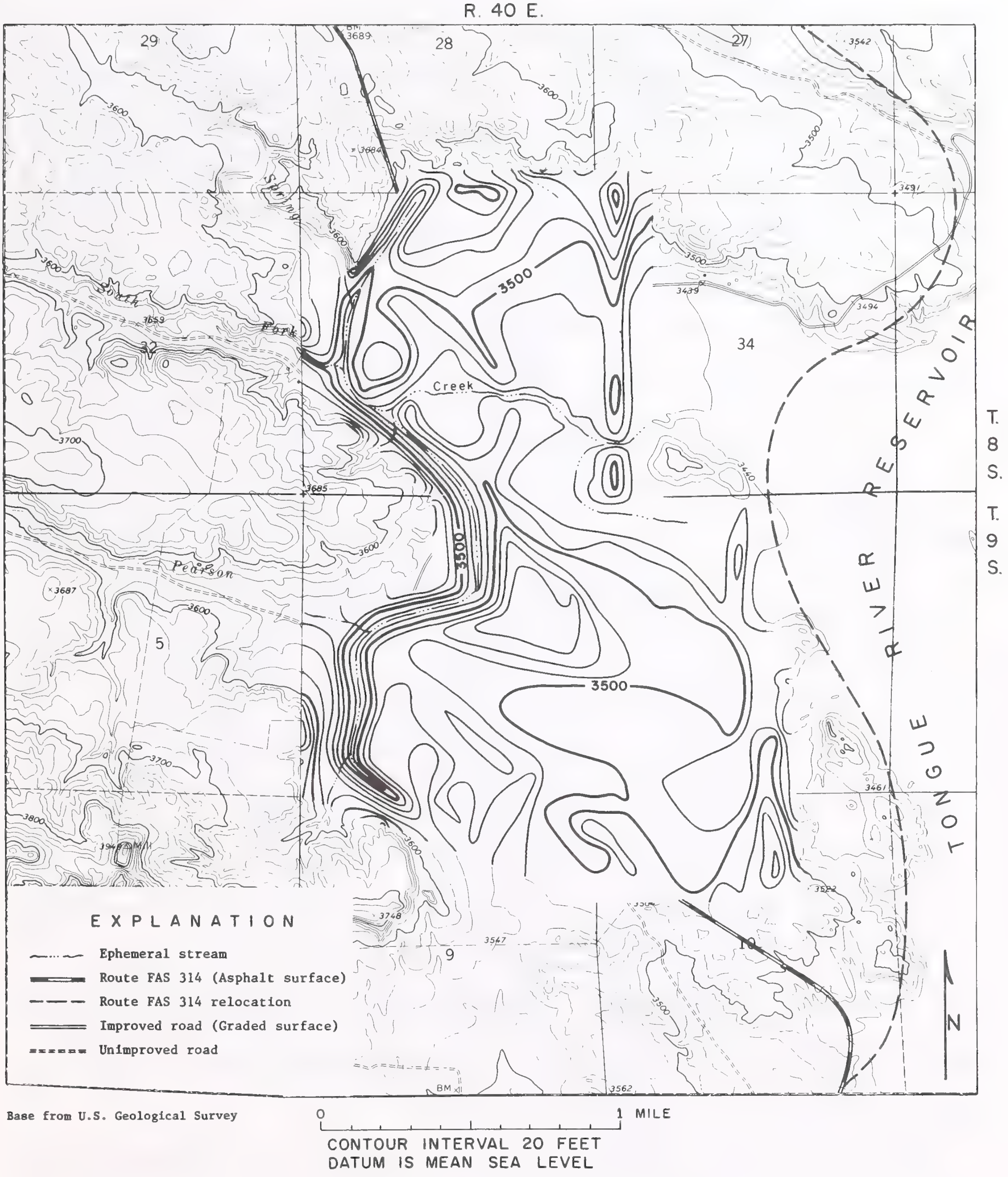


Figure 18.-16-yard shovel used to load coal into hauler at the West Decker mine.



Base from U.S. Geological Survey

Figure 19. — Proposed topography and drainage after mining in the North Extension area.

Reduction of the final highwall to a 20 degree (36 percent) or less slope would produce an elongate, shallow, V-shaped depression along the western edge of the mined area. The remainder of the reclaimed area would be a gently rolling terrain with a 5 to 1 (20 percent) or less slope. Recontouring of the spoils would be kept within two spoil ridges of the active pit. Any spoil material that is not conducive to revegetation would be buried more than eight feet below the surface of the regraded spoil.

(b) Topsoiling

Topsoiling the leveled spoils would be done using the same procedures as those described for the East Decker mine (p. 38).

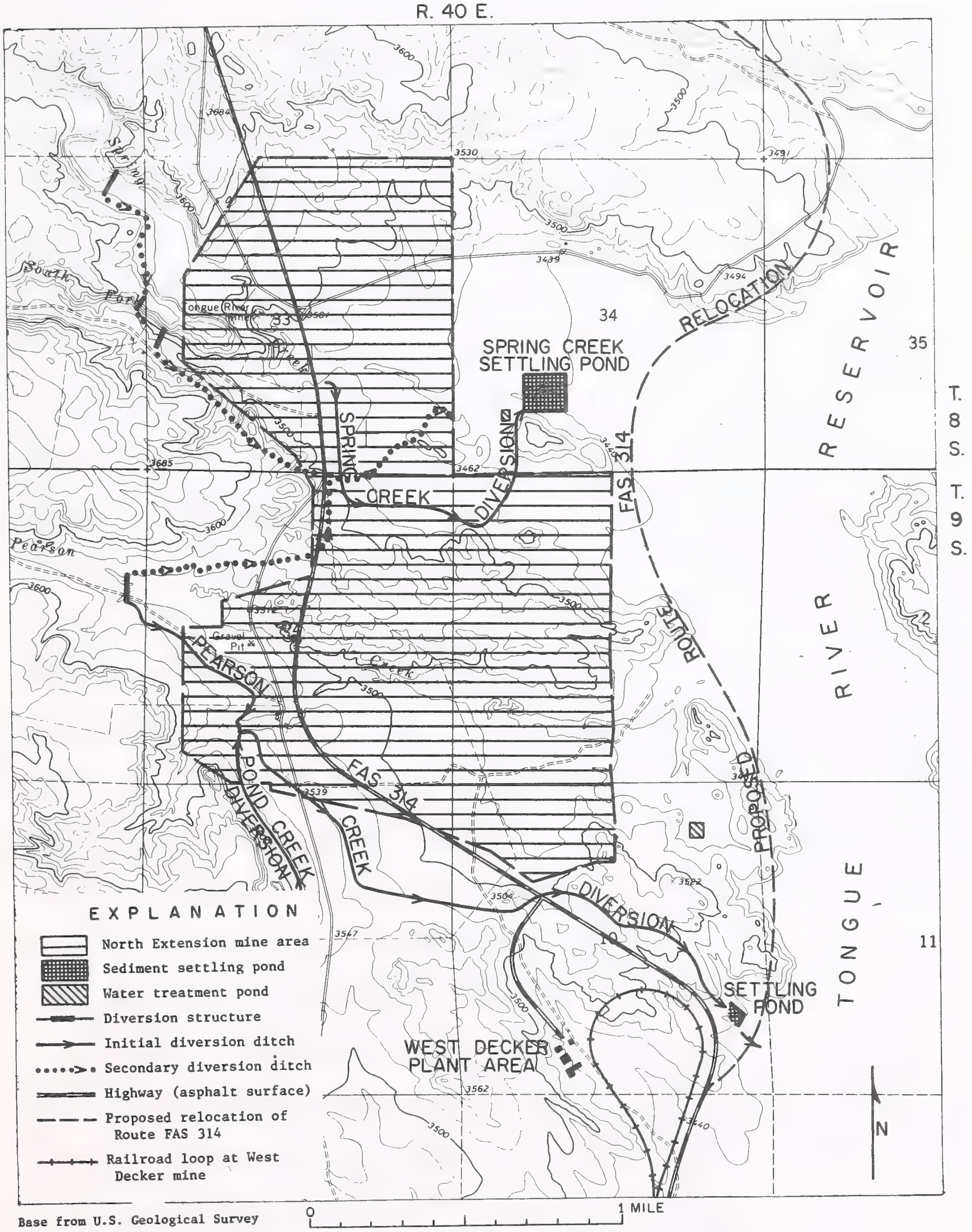
(c) Seeding

Seeding procedures would be the same as those described for the East Decker mine (p. 38).

(5) Water diversion and impoundment

The North Extension mine would traverse the full width of the lower reaches of both Spring Creek and Pearson Creek valleys. It would be necessary, therefore, to intercept and divert around the proposed mine area the ephemeral streams that drain both of these watersheds. Spring Creek has a drainage area of 35.7 mi^2 upstream from the proposed mine boundary. Similarly, Pearson Creek has a drainage area of 7.5 mi^2. Flow through the Pond Creek diversion, which has a contributing area of 2.8 mi^2, enters the Pearson Creek drainage upstream from the mine area and increases the contributing area of that stream to 10.3 mi^2. Locations of proposed diversion dams and channels are shown in figure 20.

Diversions of both Spring and Pearson Creeks would be accomplished in two phases, an initial phase and a secondary phase. The initial diversion of Spring Creek would extend generally southward from the downstream end of



Base from U.S. Geological Survey

Figure 20. — Proposed water-diversion system and highway relocation in the North Extension area.

the culverts beneath Route FAS 314. This channel, which would be constructed to carry a maximum discharge of 1,800 ft^3/s, would follow a semicircular path 6,600 feet long around the southern end of the north pit (fig. 20) and would discharge into a settling pond on Spring Creek located downstream from the mine area. This pond would have an initial capacity of 140 acre-feet and a maximum depth of 15 feet. Inflow to the pond would be through a riprapped drop designed to prevent local scour; outflow would be through an earthen channel blended to meet the existing channel of Spring Creek on grade. The pond has been designed to retain inflow from both Spring and Pearson Creeks a minimum of 1 hour, which should be adequate to remove all but the clay and possibly the fine silt fraction from suspension. Outflow would be of equal or better quality than flow in existing channels at comparable discharges.

The first 4,230 feet of diversion channel downstream from the point of intake would have earthen banks and bed on a slope of 0.003. The trapezoidal-shaped channel typically would be 12 feet wide at the bottom, at least 9 feet deep, and have sides sloping 1.5:1. This earthen channel would merge into a concrete-lined channel or drop 377 feet long with a slope of 0.0385. The trapezoidal-shaped drop would be 7 feet wide at the bottom, 4 feet deep, and have sides sloping 1:1. The remaining length of the diversion would have earthen banks and bed and the same slope and cross section as the first 4,200 feet of channel. The concrete-lined channel would be baffled where it exits into the earthen channel, and the transitional area would be riprapped to prevent local scour. The earthen channel would carry flows beneath the haul road through two culvert pipes, each 12 feet in diameter.

As mining progresses westward, the pit would intersect this initial diversion of Spring Creek in a period of 6 to 9 years, requiring the construction of a replacement or secondary diversion system (fig. 20). A dam would be built across the main stem of Spring Creek upstream from the old Tongue River mine. Outflow from this structure would drain generally southward through an excavated channel into the reservoir formed by a similar dam built across South Fork Spring Creek. This channel would be designed to carry a maximum discharge of 1,000 ft^3/s. Outflow from the reservoir on the South Fork would be diverted around the south side of the north pit in an excavated channel designed to carry a maximum discharge of 1,800 ft^3/s. This flow would be returned to the old channel of Spring Creek downstream from the initial box cut and would pass through the settling pond previously described. The engineering design for this future relocation has not been finalized pending the observation and testing of the initial diversion system and the collection of stream-flow records for several years on both Spring and South Fork Spring Creeks. The added hydrologic data should provide a much better basis for the design of stable diversion structures and channels.

Initially, a diversion dam about 625 feet long and 18 feet high would be constructed across Pearson Creek about a quarter of a mile upstream from the west margin of the mine area (fig. 20). Outflow from this structure, which initially would impound water to a depth of about 12 feet, would be diverted generally southeastward around the south side of the pit through an excavated channel 14,100 feet long and designed to carry a maximum discharge of 1,000 ft^3/s. This diversion would incorporate and utilize the flood storage offered by an existing impoundment on a tributary of Pearson Creek and would empty into a settling pond constructed in the SE¼ sec. 10, T. 9 S., R. 40 E. (fig. 20). The settling pond would have an initial capacity of 50 acre-feet and a maximum depth of 15 feet. Its function would be similar to that of the settling pond on Spring Creek. Inflow to and outflow from the pond would be through concrete-lined drops equipped with baffles and riprap to prevent local erosion.

The first 3,600 feet of diversion channel, extending downstream from the diversion dam on Pearson Creek to the juncture with the Pond Creek diversion channel, would be constructed to carry a maximum discharge of 700 ft^3/s. It would have earthen banks and bed on a slope of 0.003. The trapezoidal-shaped channel typically would be 12 feet wide at the bottom, 5.5 feet deep, and have sides sloping 1.5:1. Downstream from the mouth of the Pond Creek diversion, the channel would be enlarged to carry a maximum discharge of 1,000 ft^3/s by increasing the depth to 7 feet. Other channel dimensions and type of construction would remain the same. About 4,000 feet downstream from the mouth of the Pond Creek diversion, the earthen channel would merge into a concrete-lined channel or drop 200 feet long with a slope of 0.07. The trapezoidal-shaped drop would be 5 feet wide at the bottom, 3 feet deep, and have sides sloping 1:1. The next 4,400 feet of channel downstream from the drop would have the same dimensions and type of construction as the channel upstream from the drop. The concrete-lined drop would be baffled where it exits into this earth channel, and the transitional area would be riprapped to prevent local scour. The earthen channel, in turn, would again merge downstream into a concrete-lined drop 1,900 feet long that would carry the flow into the sediment settling pond. The first 180 feet of this drop would have a slope of 0.055. The trapezoidal-shaped channel would be 5 feet wide at the bottom, 3 feet deep, and have sides sloping 1:1. The remainder of the drop would have a slope of 0.0285 and a cross section similar in shape, but 0.5 foot deeper than the first 180 feet of the drop to compensate for the decreased slope.

As mining progresses westward on the south pit, the initial diversion from Pearson Creek would be intercepted in a period of 15 to 18 years. It would be necessary, therefore, to construct a replacement or secondary diversion system, which would utilize the same diversion dam across Pearson Creek. The initial diversion channel would be abandoned and a second channel having the same carrying capacity would be constructed around the north end of the south pit. This channel would connect with the secondary diversion channel from Spring Creek (fig. 20), which then would carry the combined flow of both Spring and Pearson Creeks to the settling pond near the mouth of Spring Creek. As previously stated, this pond would be initially constructed to function under the combined flows of these two streams. As previously stated for the Spring Creek diversion, the engineering design for this future relocation of the Pearson diversion has not been finalized pending the collection of additional hydrologic data that should provide a much better basis for the design of stable channels.

At the conclusion of mining, all dams and diversion ditches on Spring Creek would be removed and the surface areas restored. Spring and South Fork Spring Creeks would follow their original channels downstream to the reclaimed mine area where they would empty into permanent drainage courses that would follow depressions designed into the final reclaimed surface. These depressions would route the water through the reclaimed area and back into the original channel of Spring Creek (fig. 19). The settling pond near the mouth of Spring Creek would be removed and the area restored.

The diversion dam and ditch on Pearson Creek also would be eliminated and the area restored. Pearson Creek would follow a depression or swale designed into the final reclaimed surface. Flow would be generally northward to Spring Creek, so that in effect, Pearson Creek would be made a permanent tributary of Spring Creek (fig. 19).

In addition to the major diversion structures, temporary contour ditches within the mine area would be used to divert any local surface runoff around the active pits.

Ground water entering the pits from exposed aquifers, estimated by Decker Coal Co. to be about 50,000 gal/day (35 gal/min), would be pumped into two mine-water treatment ponds (fig. 20) where the water would be treated as necessary before being released into the natural drainages. Water for dust control would be obtained from these ponds, which would have a total capacity of 150,000 gallons (0.46 acre-feet).

(6) Employment requirements

Approximately 50 construction-related employees would be utilized. The total permanent work force over the life of the mine should average about 70 people. This level of employment should be reached in the first year of operation.

e. Mining facilities and equipment

(1) Roads

(a) Public highway relocation

That part of Route FAS 314 that crosses the proposed mine area would be removed during mining operations. A new roadway would be built east of the proposed mine area, approximately paralleling the west shoreline of the Tongue River Reservoir (fig. 20). About a mile north of the mouth of Spring Creek this road would turn northwestward up an unnamed ephemeral stream valley to rejoin the existing highway. The length of the relocated highway would be 6.46 miles, compared to 5.07 miles between common points on the existing highway. The relocated highway would meet standards set by Montana Department of Highways for secondary highways. Construction methods would meet all applicable State and Federal laws and regulations. All engineering, construction, and right-of-way costs would be borne by the Decker Coal Co.

The proposed relocation of FAS Route 314 would traverse rather rolling ground with short sections of up to five percent grade. The average grade would be in the two to three percent range, which is similar to the existing highway.

Decker Coal Co. owns in fee or has leasehold on approximately two-thirds of the acreage required for their proposed highway relocation. The Montana Department of Natural Resources and Conservation and the Bureau of Land Management control the balance of the surface required for right-of-way.

(b) Haul roads

Two haul roads would be constructed. Both would be 60 to 70 feet wide and surfaced with clinker from the mine area. The initial location of the haul roads is shown in figure 13. Although the location of these roads must be changed as the mining front advances, in general the roads would be kept as short as possible. Topsoil would be removed and stored prior to road construction. Haul roads would be maintained with a motor patrol and would be wetted as necessary to control dust using a water-spray truck, which would obtain water from treatment ponds. Surface runoff would be controlled by drainage ditches along the edges of the roadway. These ditches would empty into the main diversion ditches.

When a road is no longer needed, the surface material would be removed and, if possible, reused. The road and adjacent area then would be shaped, topsoiled, and seeded at the earliest appropriate time.

(2) Railroad

The mine would use the existing loading facilities at the West Decker mine and, therefore, would not require the construction of additional railroad lines.

(3) Power

A 34.5 kv power transmission line would be constructed to connect with the existing Pacific Power & Light substation south of the West Decker mine. This line would parallel the west side of the mine with stub feeders extending eastward through the center and along the north and south margins of the mine area. Portable transformers would be used to reduce voltage, and flexible cables would be used to distribute power from the transformers to the equipment. Powerlines would conform to REA specifications for protection of birds against electrocution. Power consumption is estimated to be 3.3 million kwh annually.

(4) Structures

No permanent structures would be constructed at the North Extension mine. Existing facilities at the West Decker mine would be used.

(5) Fuel and explosives storage

Existing facilities at the West Decker mine would be used. No expansion of those facilities would be necessary. Annual consumption of diesel fuel and gasoline is estimated to be 430,000 gallons and 40,000 gallons respectively. Ammonium nitrate use is estimated to be 4 million pounds annually.

(6) Coal processing and storage facilities

Existing facilities at the West Decker mine would be used. No expansion of those facilities would be necessary.

(7) Water supplies and waste disposal

Existing facilities at the West Decker mine would be used. No expansion of those facilities would be necessary. An estimated 30,000 gal/day of water would be used for dust control. This water would be obtained from mine effluent (Jack Reed, Decker Coal Co., oral communication).

(8) Mining and reclamation equipment

Following is a list of the major equipment that would be used in mining and reclamation work:

1	Bucyrus Erie 41-yard dragline (fig. 16)
1	Bucyrus Erie 16-yard shovel (fig. 18)
4	Wabco 150-ton bottom-dump trucks

Other mining and support equipment would be shared with the East and West Decker mines. However, sufficient equipment would be obtained to insure efficient operation of all three mines.

4. Transportation and marketing of the coal

a. Methods and routing

Coal from the East Decker and North Extension mines would be transported directly by unit trains of 10,000-ton capacity (100 cars, each carrying 100 tons) to utility companies in Illinois and Texas or to terminal facilities in Wisconsin and Illinois where coal would be loaded on boats or barges and shipped to power generation plants in the Detroit and Chicago areas. Maximum combined coal production from the two mines would require about 17-18 unit trains per week in addition to the 19-20 unit trains per week from the existing West Decker mine, all of which would be routed over the Decker spur to the Burlington Northern main line just east of Sheridan, Wyoming. Actual routing of trains beyond this point would be at the discretion of the railroads, but in general, the trains probably would follow the most direct main line routes.

Coal destined for Detroit Edison plants in southeastern Michigan would be transported by Burlington Northern Railroad to Superior, Wisconsin, loaded on boats, and shipped on the Great Lakes to the Detroit area. About half the coal destined for Commonwealth Edison plants in Illinois would be transported by Burlington Northern Railroad to Havana, Illinois, loaded on barges, and shipped on the Illinois River to the Chicago area. Some unit trains, however, would be routed directly by Burlington Northern to the Chicago area. All coal to be used by the Lower Colorado River Authority would be transported directly by rail to Austin, Texas.

b. Market locations and use of the coal

Coal from the East Decker mine would be used by Commonwealth Edison of Chicago, Illinois, and by the Lower Colorado River Authority of Austin, Texas. Coal from the North Extension mine is committed to Detroit Edison of Detroit, Michigan. All coal would be used for electric-power generation.

5. Possible future Decker Coal Co. operations in the area.

Coal reserves that can be mined by surface methods in the East Decker area significantly exceed those committed to the proposed East Decker mine. Very probably, therefore, additional areas on the lease will be mined. The company has indicated in its mining plan for East Decker that section 1 immediately north of the proposed plant area is a possible future mining area. Much of the remainder of the lease is less favorable for surface mining than the proposed mine. This is not to imply, however, that other parts of the lease cannot be mined.

Coal reserves in the West Decker area will be largely removed by the existing West Decker mine and the proposed North Extension mine. No additional mining probably will be undertaken on leases in this area.

The Decker Coal Co. currently has no plans to use underground methods to mine any coal on their leases in the Decker area. In the future, however, it is possible that underground methods would be used to mine those parts of the Anderson, Dietz 1, and Dietz 2 coal beds that cannot be economically mined by surface methods and the Canyon, Wall, and "A" beds, which underlie the surface at depths of 300-700 feet (fig. 33).

On August 25, 1975, the Decker Coal Co. filed for a modification of Federal leases Montana 057934 and Montana 057934-A to add to these leases additional lands lying between the lease boundaries and the Tongue River Reservoir in sec. 34, T. 8 S., R. 40 E., and sec. 3, T. 9 S., R. 40 E. If these modifications can be coordinated with the approval of the mining plan, the mining sequence in the North Extension area would be modified accordingly. A discussion of this possible change in the plan is covered under alternatives, section VIII. F.

Any significant modification of the mine plans as approved or the proposed development of other new mines in the area probably would require further environmental analysis and a determination of the need for additional environmental impact statements by the Federal and State agencies concerned in accordance with their respective established procedures.

B. Proposals for other developments in the area

1. Proposed High Tongue River Dam project

The existing Tongue River Reservoir provides a firm annual yield of 40,000 acre-feet of water, virtually all of which is committed to existing users. Additional agricultural and industrial development in the Tongue River watershed, therefore, is contingent on the development of additional water supplies. During the past decade, a considerable effort has been made by the Montana Department of Natural Resources and Conservation to appraise the feasibility of significantly increasing the capacity of the existing Tongue River Reservoir. As a part of that effort, a feasibility study completed by the Bechtel Corporation of San Francisco, California, produced the following general conclusions:

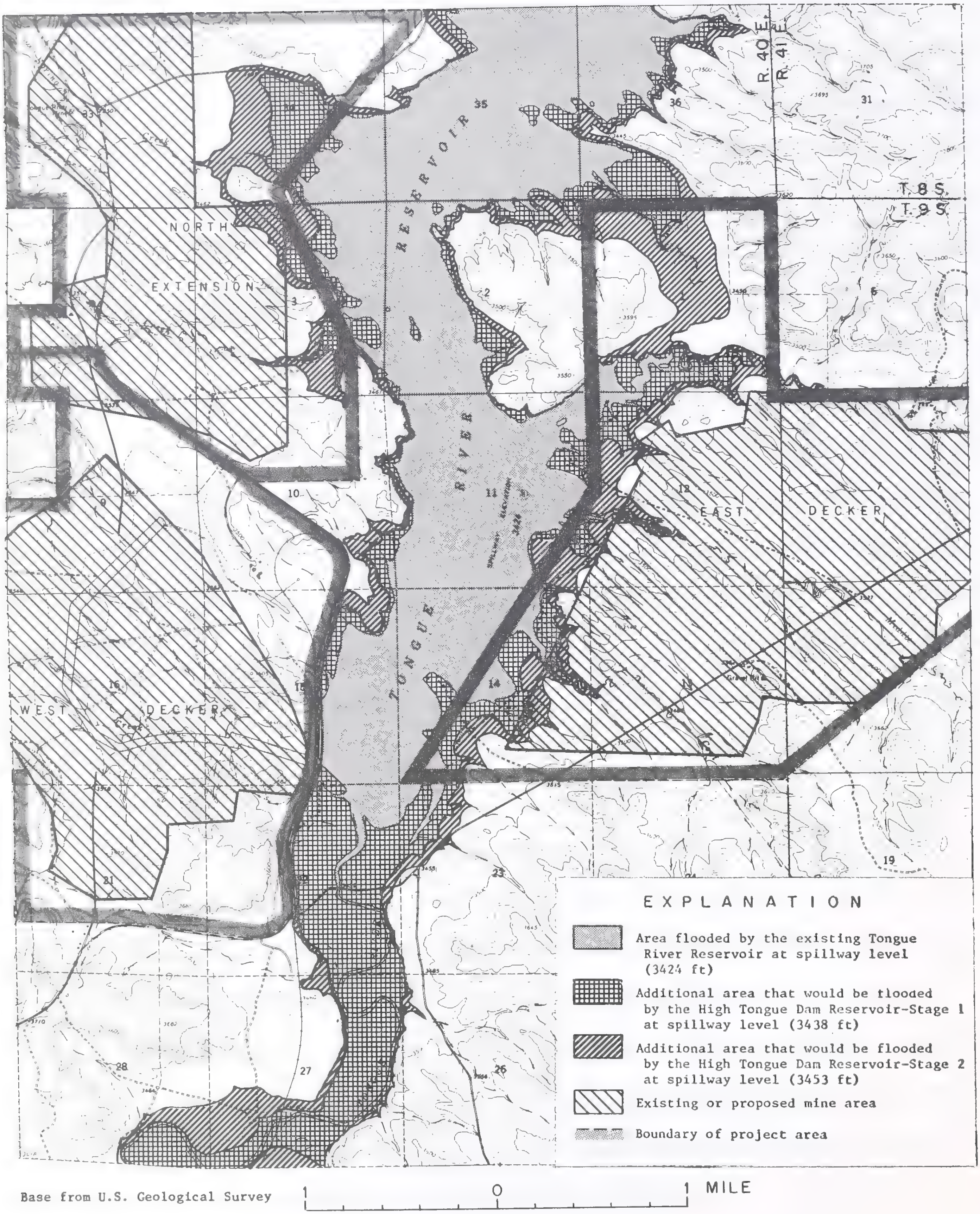
A maximum storage of 140,000 acre-feet with a firm annual yield of 72,000 acre-feet could be obtained by raising the existing dam to its greatest feasible height. The estimated direct construction cost (1968) would be about $4,000,000. This approach would less than double the firm annual yield of water to downstream users. Should more water eventually be needed, which is highly probable, a higher structure must be built downstream, inundating the raised dam. It appears doubtful that the cost of raising the existing structure could be amortized.

A new structure called the High Tongue Dam could be built downstream from the existing dam. Two potential sites exist, the Oxbow site about 3.9 miles downvalley, northeast of the existing dam and the Montana High Dam site about 5.5 miles northeast of the existing dam. The second site, also called the Fourmile Creek site, was considered the most favorable because of poor foundation conditions at the Oxbow site.

The design of the High Tongue Dam incorporates two possible stages of construction, depending on the height of dam desired. Stage I provides for a structure having a spillway elevation of 3,438 feet -- 14 feet higher than the existing structure. The reservoir thus formed would have a maximum capacity of about 320,000 acre-feet and a firm annual yield of about 100,000 acre-feet. It would impound water upstream to about the Montana-Wyoming line. The dam would be 200 feet high, 3,200 feet long, and would require 10 million cubic yards of earth fill. The spillway would be designed to pass the maximum probable flood of 183,000 ft^3/s, and the outlet structure would pass 3,000 ft^3/s. In 1968 the estimated direct or specific cost was $22,133,000; the estimated total cost, direct and indirect, was $32,229,000. The area flooded at spillway level (3,438 feet) is shown in figure 21. The effects of flooding in the East Decker and North Extension project areas are discussed in the section on impacts.

Stage II provides for raising the spillway level of the High Tongue Dam an additional 15 feet. The reservoir then would have a maximum capacity of about 450,000 acre-feet and would back water into Wyoming. Firm annual yield of water would be about 112,000 acre-feet.

Should the High Tongue Dam be constructed, its operation would be similar to that of the existing structure. To simulate operation of the


R. 40 E.
R. 41 E.
T. 8 S.
T. 9 S.
TONGUE RIVER RESERVOIR
SPILLWAY ELEVATION 3424
NORTH EXTENSION
EAST DECKER
WEST DECKER
Creek
35
36
31
2
1
6
10
11
12
9
16
15
14
21
23
19
28
27
26
EXPLANATION
Area flooded by the existing Tongue River Reservoir at spillway level (3424 ft)
Additional area that would be flooded by the High Tongue Dam Reservoir-Stage 1 at spillway level (3438 ft)
Additional area that would be flooded by the High Tongue Dam Reservoir-Stage 2 at spillway level (3453 ft)
Existing or proposed mine area
Boundary of project area
1
0
1 MILE

Base from U.S. Geological Survey

Figure 21.—Map showing areas flooded by the existing Tongue River Reservoir and by the proposed High Tongue Dam Reservoir.

proposed stage I reservoir, a routing analysis was made. This analysis assumed the reservoir to be initially filled to maximum stage and then budgeted inflow, outflow, evaporation losses, and precipitation on a monthly basis using 1945-1966 data. The assumption also was made that high flows would pass through the spillway. In actual operation, water would be released from storage through the outlet tunnel in anticipation of high inflows from snowmelt runoff as indicated by snow surveys. Annual values of maximum, average, and minimum storage obtained from this analysis are shown in figure 22.

Personnel in the Montana Department of Natural Resources and Conservation report that it is unlikely that a dam backing water into Wyoming will be built in the predictable future. A stage I structure is generally regarded as the more feasible proposal. No tentative schedule has been established for completion of this project; however, it is doubtful that construction would be initiated within the next decade.

2. Development of coal on the Crow Indian Reservation

Shell Oil Company has a coal lease on 30,247 acres on the Crow Indian Reservation, Big Horn County, Montana. A mining plan has been submitted to the U.S. Geological Survey for approval that proposes surface mining of coal in Youngs Creek Valley in the extreme southeastern corner of the Reservation about 8 miles west of the Decker area. This mine was designed to produce about 8 million tons of coal annually over a period of about 20 years and would have separate facilities and transportation systems. The proposed starting date was 1977. Coal would be shipped by railroad to Houston, Texas, and to New Roads, Louisiana, where it would be used for power generation.

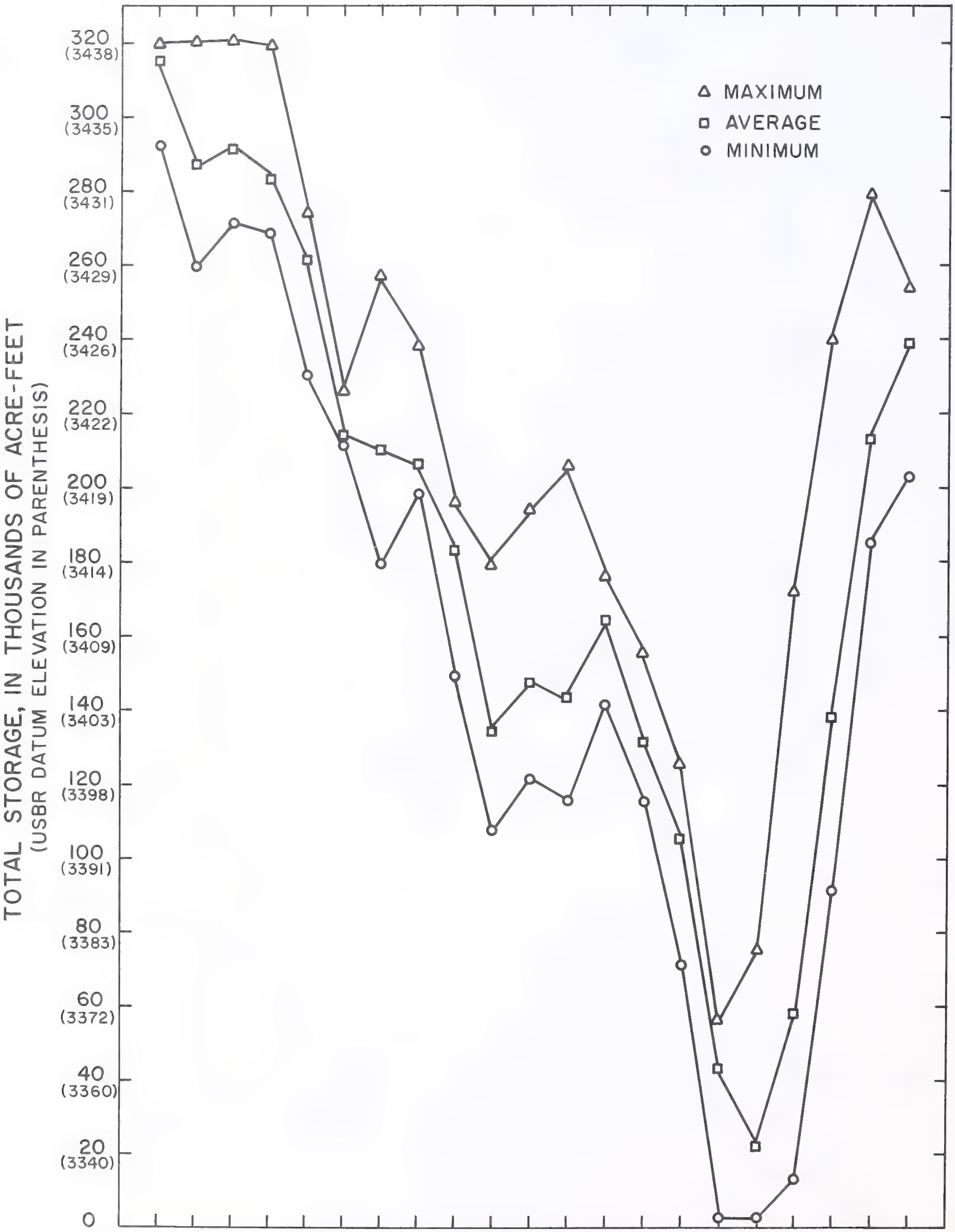


Figure 22.-Expected storage in the High Tongue Dam reservoir based on a routing analysis using runoff data for the period 1945-66.

The Crow Reservation contains extensive coal resources, a significant part of which are held under various leases or options to lease. Late in 1975, however, the Tribe initiated proceedings to cancel all such commitments, except for two leases held by Westmoreland Resources. Westmoreland Resources is currently preparing a mining plan covering the expected 20-year life of their mine on Sarpy Creek on ceded Crow lands (see table 1). A joint U.S. Geological Survey--Bureau of Indian Affairs environmental impact statement on the proposal is in preparation.

Possible development of the coal resources of the Northern Cheyenne Reservation has also been halted by Tribal action in recent years.

3. Development of coal in the Spring Creek watershed

Pacific Power and Light Co. holds a Federal coal lease (Montana 069782) on 2,346.76 acres in the drainage basin of Spring Creek about 2 miles northwest of the North Extension area (fig. 23). The company began detailed exploration work on this lease in 1975 and tentatively plans to open a surface coal mine in this area within the next 5 years.

The prospect area includes the bottoms of both Spring and South Fork Spring Creek valleys and the intervening upland. Coal beds to be mined are the Anderson, Dietz 1, and Dietz 2 beds, which are locally combined to form a single coal bed about 80 feet thick (p. 124).

C. Existing coal mining in the area

The West Decker mine was opened in 1972 by the Decker Coal Co. and currently (1975) produces about 9 million tons of coal annually (table 1). The mine area (fig. 2) covers about 1,460 acres, 600 of which are on State lease 527. The remainder are on Federal leases Montana 057934A and Montana 061685 (fig. 1). The mining plan for that part of the area that lies on Federal leases was approved by the U.S. Geological Survey on April 10,

1972. Plans for the area under State lease must be approved annually. Similarly, a mining permit covering all Federal and State lands disturbed each year must be obtained annually from the Montana Department of State Lands.

The mine area (fig. 2) includes all coal in the Anderson-Dietz 1 bed that can be recovered economically in this part of the Decker area. The northeast margin of the mine area is determined by the merchantable limit of the Anderson-Dietz 1 bed; the southern margin is defined by a fault that interrupts the continuity of the coal and by high ground that makes the thickness of the overburden excessive. Expansion westward is also limited by the increasing thickness of the overburden. The Dietz 2 bed is not economically recoverable by surface methods at the West Decker mine.

Over the past 60 years, more than 50 million tons of coal have been mined by surface and underground methods in the vicinity of the towns of Acme and Monarch, Wyoming, about 15 miles southwest of the Decker area. The coal was used for railroad, industrial, and domestic purposes. About 44 million tons were mined by surface methods at Colstrip, Montana, about 55 miles north of the Decker area. This coal was mined during the period 1923-58 by the Northern Pacific Railroad Co., largely for its own use. Six major surface coal mines and one comparatively small mine are currently (1976) operated or under development within 100 miles of the Decker area (fig. 23). Data for these mines are summarized in table 1.

Table 1.--Summary of existing mines within 100 miles of the Decker area

Name of mine	Operator	Coal ownership	Start of production (year)	1976 annual production (million tons)[1]	Employment[1]	Utilization of coal	Market areas
West Decker	Decker Coal Company	Federal and State	1972	10.2	326	Electric power generation	Illinois
Big Horn	Big Horn Coal Company	Fee	1944	1.8	82	Electric power generation; industrial and domestic heating	Wyoming
Colstrip (Rosebud)	Western Energy Company	Federal and fee	1968[2]	9.3	299	Electric power generation; industrial heating	Minnesota Illinois N. Dakota Montana
Big Sky	Peabody Coal Company	Federal and fee	1969	2.4	82	Electric power generation	Minnesota
Sarpy Creek (Absolaka)	Westmoreland Resources	Indian	1974	4.1	93	Electric power generation	Iowa Wisconsin Minnesota
Welch	Welch Coal Company	Fee	1949	.03	2	Electric power generation	Sheridan, Wyoming
Ash Creek	Ash Creek[4] Mining Company	Fee	1978[3]	0.5[5]	30[3]	Electric power generation	Oklahoma

[1] Data from coal company records as of December, 1976.

[2] 44 million tons were mined in the 35-year period, 1923-58, by the Northern Pacific Railroad Co.

[3] No coal production to date. Current employment is for development purposes.

[4] Public Service Company of Oklahoma.

[5] Estimated production rate after 1978.

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

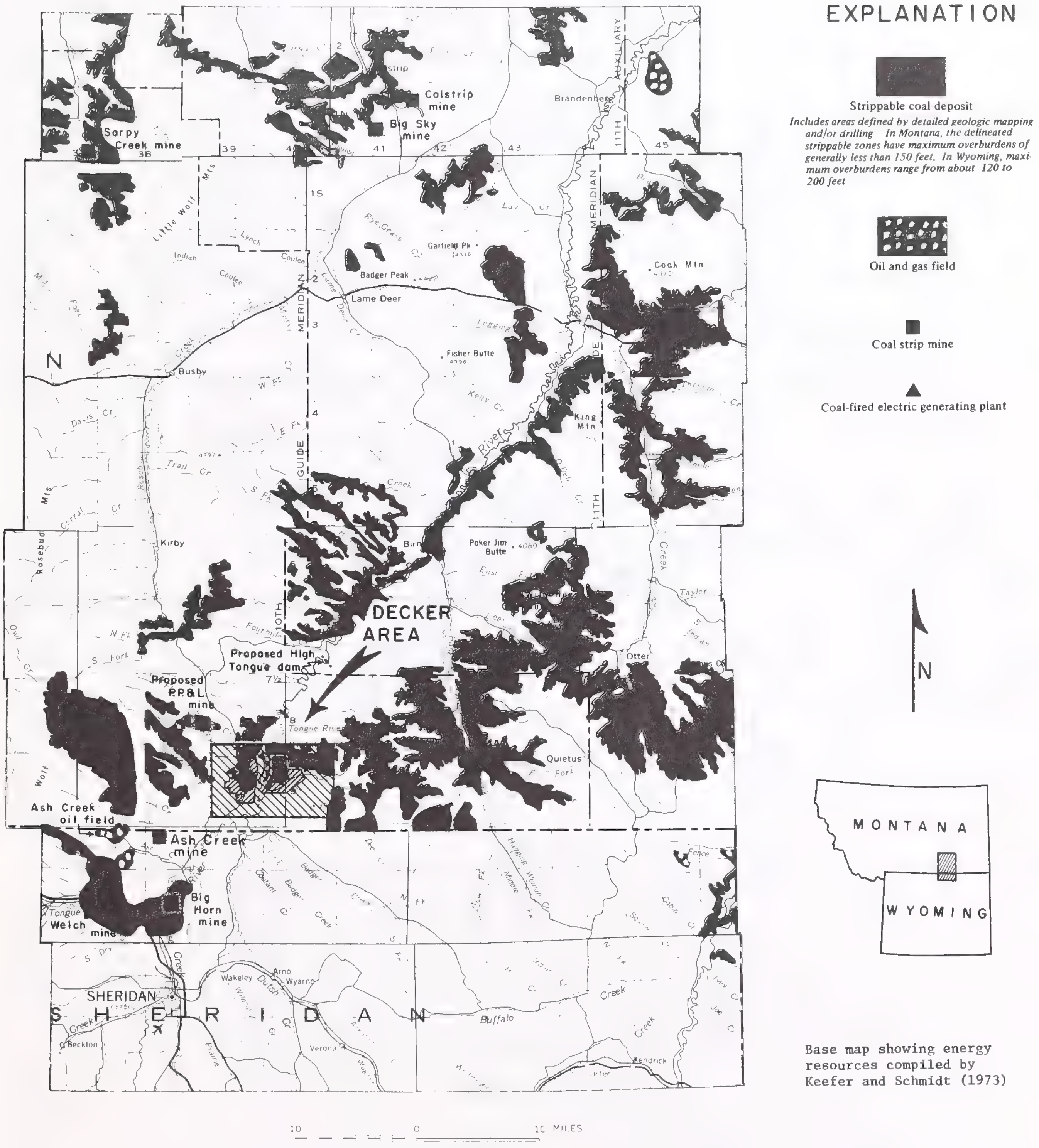
A. The Physical environment

1. Location and description of the area

The general area described in this report lies near the western edge of the Great Plains physiographic province (Fennemen, 1931) within sight of the Bighorn Mountains. Surface drainage is to the Tongue River, which flows generally northeastward about 110 miles to its confluence with the Yellowstone River.

More specifically, the report area--hereafter referred to as the Decker area--is in the southeast corner of Big Horn County about 5 miles north of the Montana-Wyoming State line and about 20 miles northeast of Sheridan, Wyoming (fig. 23). Sheridan is the only community of appreciable size within a radius of about 50 miles. The Decker area, which takes its name from the nearby Decker Post Office, lies astride the Tongue River Reservoir and covers about 60 square miles (fig. 3). Included within this larger area are three project areas. The West Decker project area covers 4.82 square miles and purportedly encompasses all lands that have been or will be disturbed in conjunction with operation of the West Decker mine. Similarly, the East Decker and North Extension project areas, which cover 5.80 and 3.63 square miles respectively, purportedly encompass all lands that would be disturbed in the proposed mining of these areas. All references in the text to the West Decker, the East Decker, or the North Extension areas apply to the lands included in these respective project areas.

Of necessity, all studies were not limited to the area shown in figure 3. Hydrologic appraisals generally included the drainage basins of all streams crossing the project areas (fig. 24). All known wells and springs



Base map showing energy resources compiled by Keefer and Schmidt (1973)

Figure 23.—Location of proposed and existing surface coal mines in northwestern Powder River Basin, Montana and Wyoming.

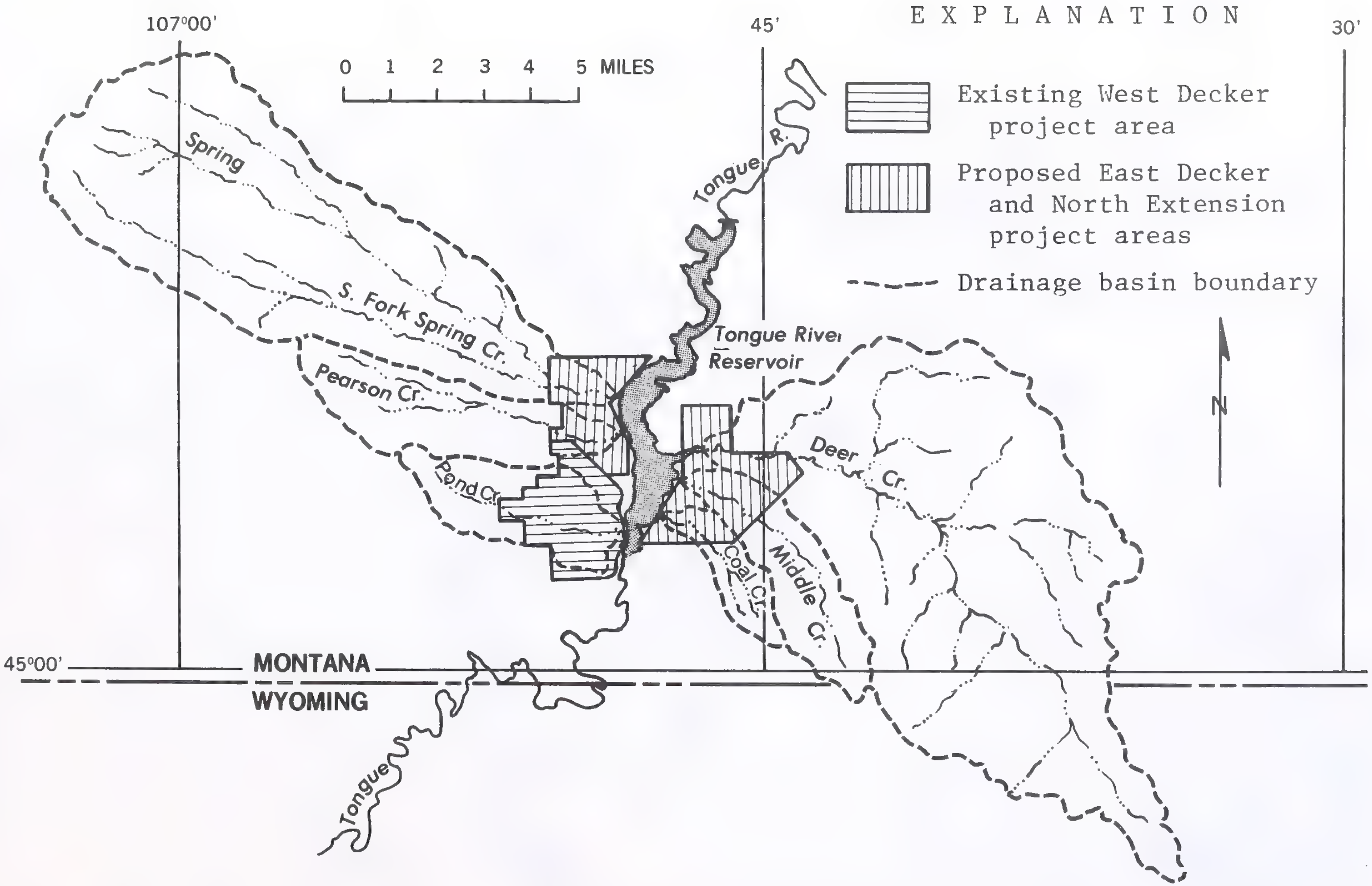


Figure 24.- Drainage basins of ephemeral streams that traverse existing and proposed project areas.

within 5 miles of the project areas, covering a total area of about 200 square miles, were inventoried. Similarly, socio-economic studies included impacts on adjacent areas and communities such as Sheridan, Wyoming.

2. Transportation routes

The Decker area is accessible from the north and south by Montana Federal-Aid Secondary Route 314 (Route FAS 314), which is a continuation of Wyoming Secondary Route 87. Route FAS 314 is an all-weather road that starts at the Montana-Wyoming line and runs generally northward about 33 miles to its junction with U.S. 212, which is the only east-west highway across south-eastern Montana. From the State line to a point about 5 miles north of the Decker area, Route FAS 314 has an asphalt surface; beyond that point the surface is coated with crushed clinker or gravel. Within the Decker area the asphalt surface is 28 feet wide, and the road has a design speed of 60 miles per hour. Traffic counts (1975) indicate that approximately 440 vehicles per day use this roadway south of the entrance to the West Decker mine. About 125 vehicles per day travel the section north of the mine entrance. Although Route FAS 314 still functions as a primary farm-to-market facility, most of the current use represents daily round trips by mine employees living in the Sheridan area.

A county road connects with Route FAS 314 immediately south and west of the Tongue River inlet to the Tongue River Reservoir and runs generally northeastward, serving the area east of the reservoir as a farm-to-market route. This road is surfaced with crushed clinker and must be maintained frequently with a motor-patrol grader. Recognized eastern termini on this road include Quietus and Otter, Montana. Traffic counts (1975) show an average daily traffic of about 70 vehicles.

Remote areas distant from Route FAS 314 and the county road are accessible only by unimproved dirt roads that receive little or no maintenance. When dry, these roads generally can be traveled by two-wheel-drive vehicles; when wet, they are traveled with difficulty even by four-wheel-drive vehicles.

Interstate 90--U.S. Primary Route 87 lies about 25 miles west of the Decker area and can be reached only indirectly by traveling southward on Secondary Routes FAS 314 and 87 almost to Sheridan or by traveling northward on Route FAS 314 to U.S. 212 and then westward about 25 miles to Crow Agency.

A railroad spur approximately 19 miles long serving the West Decker mine connects with the Burlington Northern main line about 5 miles east of Sheridan. This spur is used primarily to transport coal from the mine and secondarily to transport materials and equipment to the mine.

No part of the Decker area is currently accessible by public transportation.

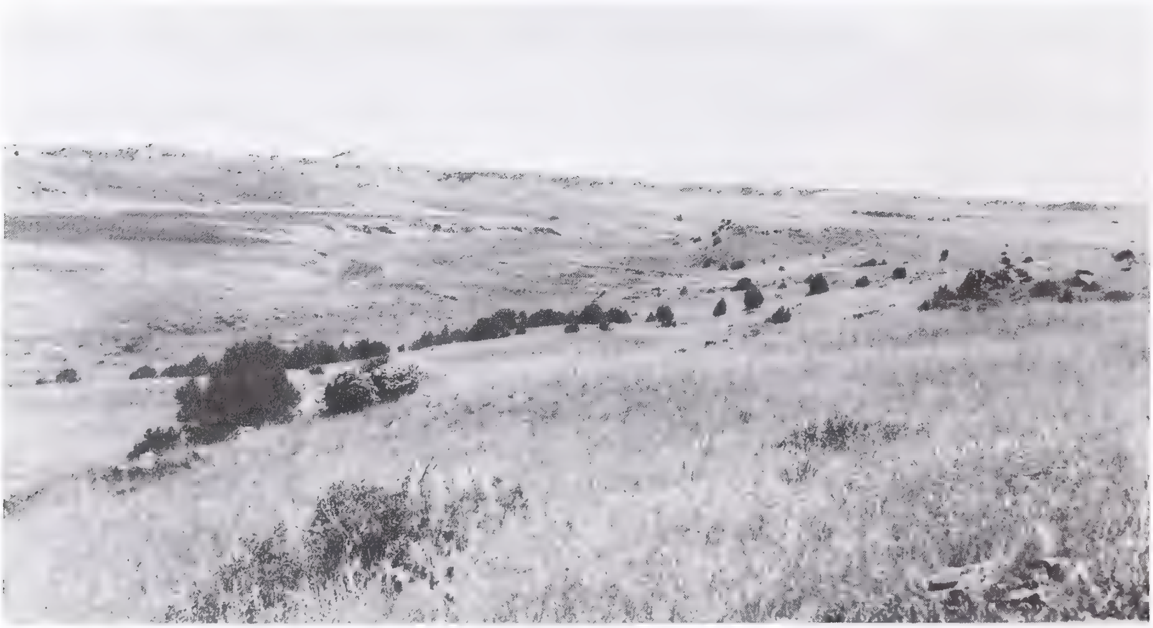
3. Topography

The valley of the Tongue River drains generally northward across the west-central part of the Decker area, dividing it into eastern and western segments. This central valley reach is somewhat wider and flatter than corresponding reaches upstream and downstream, forming a natural reservoir basin that has been partially flooded by construction of a dam across the Tongue River about 2½ miles north of the Decker area. The configuration of the present reservoir shoreline closely reflects the meander patterns of the ancestral Tongue River. Spillway level of the reservoir is 3,424 feet. Topographic features in the area are shown in figure 3.

The area east of the Tongue River Reservoir is drained by three streams, all of which are ephemeral. Deer Creek is the largest; Middle Creek and Coal Creek are comparatively small (fig. 24). The flow, channel, and watershed characteristics of these and of other streams west of the reservoir are described in the section on hydrology. Slopes on the broad upland area south of Deer Creek within the proposed mine area (fig. 25-A) seldom exceed 15 percent. Eastward, however, the land surface rises across a series of irregularly dissected benchlands toward the high, intricately dissected, ancient terrace surface or highland that forms the drainage divide (fig. 25-B). This divide is about 800 feet higher than the level of the Tongue River Reservoir. The benchlands are commonly dissected by deep V-shaped valleys and separated from one another by steep, eroding escarpments 100 feet or more high (fig. 26-A). From a distance they locally resemble giant stair steps rising toward the skyline. The upper reaches of Middle and Coal Creeks drain the north and northwest slopes of the Badger Hills, which reach a maximum altitude of about 4,600 feet. These valleys are typically narrow, steep sided, and have gradients in excess of 100 feet per mile (fig. 26-B). The area north of Deer Creek is intricately dissected and difficulty accessible. Slopes are characteristically steep and subject to rapid erosion.

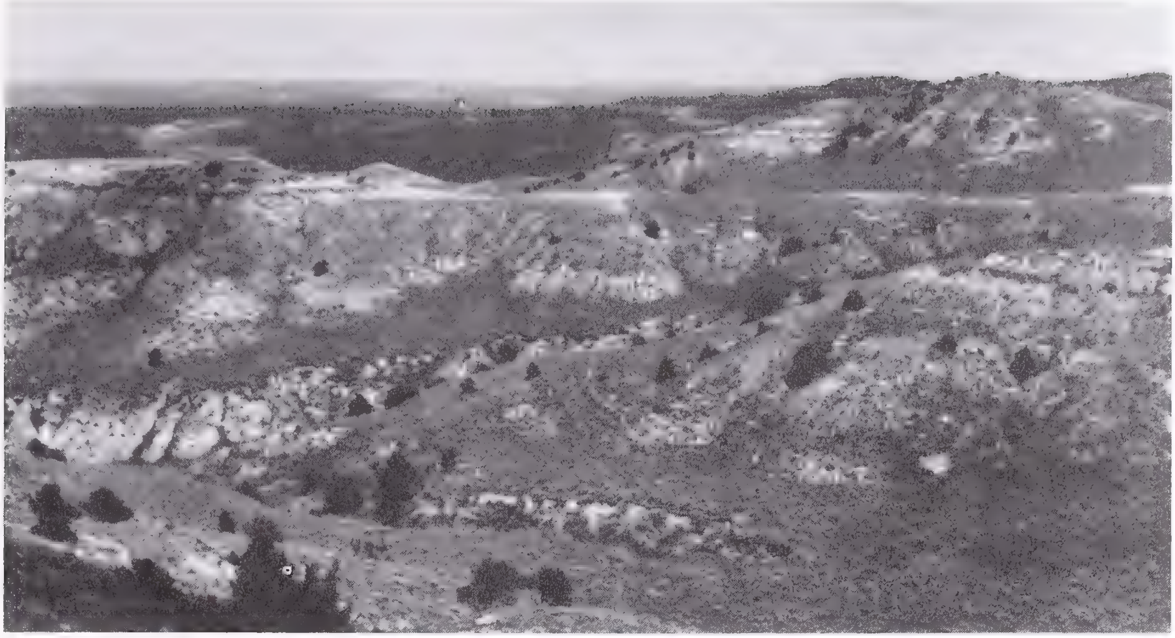
The area west of the Tongue River Reservoir, like that to the east, is also drained by three ephemeral streams (fig. 27). Spring Creek is the largest, Pearson Creek and Pond Creek are comparatively small (see section II. A.8., Hydrology). The broad lower reaches of these stream valleys (fig. 27-A) and the low interstream divides form a rolling, locally hummocky terrain characterized by slopes generally less than 8 percent. About 1½ to 2 miles west of the reservoir, the valleys of Spring, Pearson, and Pond Creeks

A. View southwestward across the East Decker area. Rolling terrain has slopes that seldom exceed 15 percent.

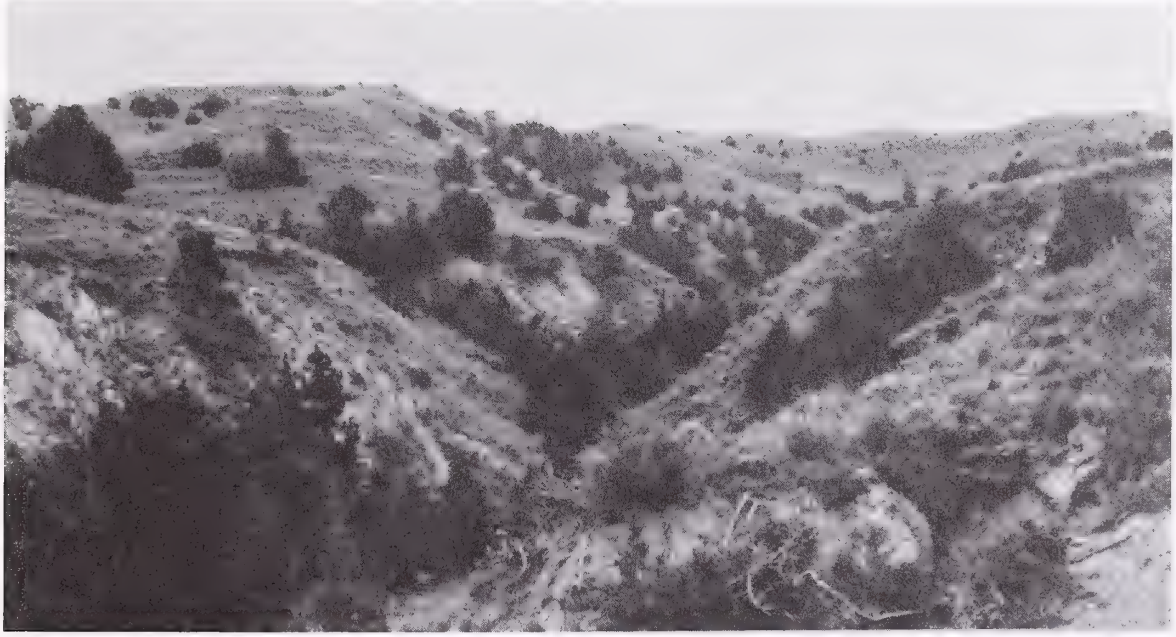


B. View eastward up Deer Creek valley towards the dissected ancient terrace surface that forms the drainage divide.

Figure 25.-East Decker project area. Rock outcrops in the foreground are clinker formed by burning of the Anderson coal bed.

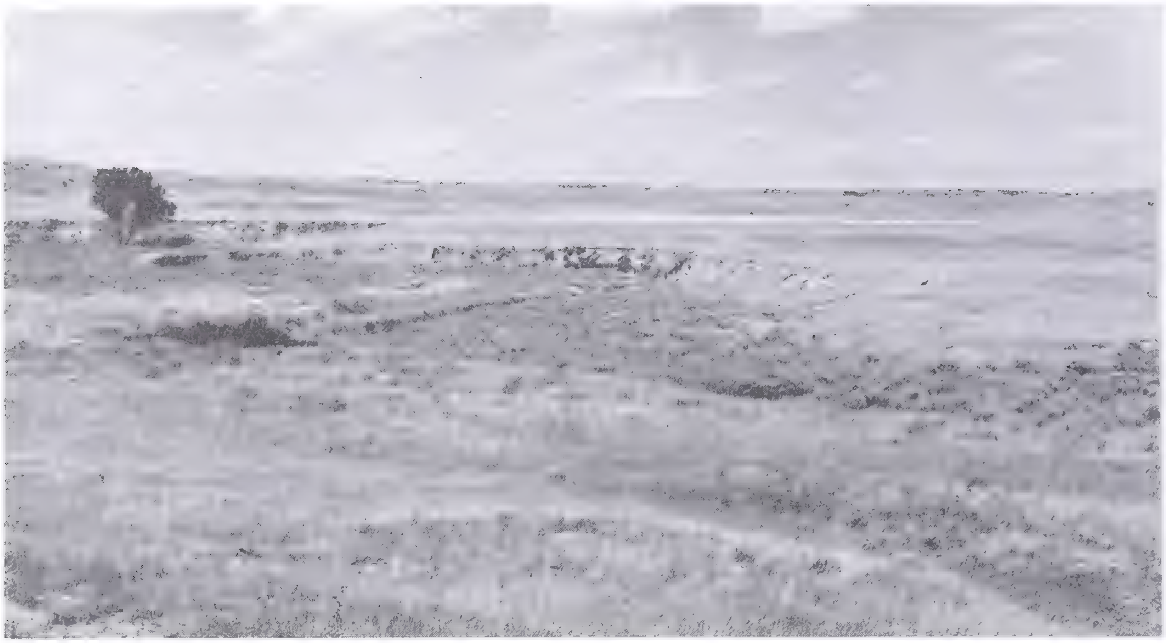


A. Benchlands dissected by incised valleys.

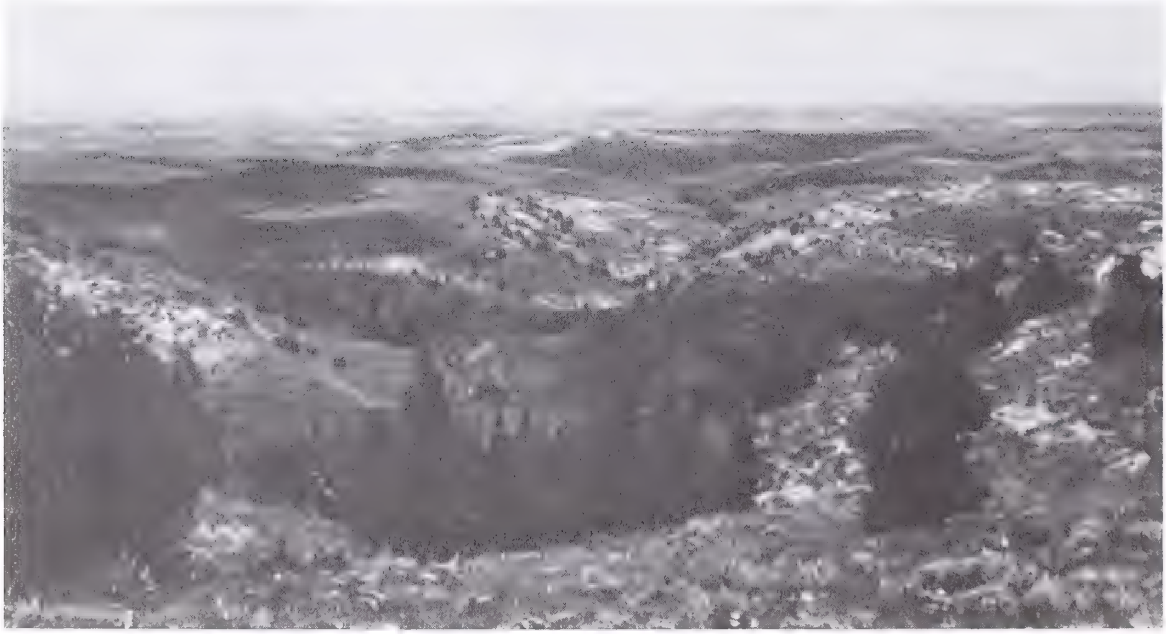


B. Typical steep narrow valleys on the north and northwest slopes of the Badger Hills.

Figure 26.-Erosional features in the upper reaches of stream valleys that traverse the East Decker area.



A. Lower reaches of stream valleys are broad and generally have slopes of less than 8 percent.



B. Upper reaches of stream valleys are generally narrow and steep.

Figure 27.-Erosional features in stream valleys that traverse the North Extension area.

narrow rapidly and the gently rolling terrain gives way abruptly to a precipitous badland topography (fig. 27-B) that forms the valley side slopes and rises steeply to the same high dissected ancient terrace surface that forms the highlands east of the reservoir. Unlike the area to the east, however, dissection is somewhat less advanced, leaving broad, high interstream areas several miles wide.

The U.S. Geological Survey has prepared a slope map of the Decker quadrangle showing four slope zones. This map, which is reproduced in part as figure 28, clearly shows the comparatively flat upland areas adjacent to the Tongue River Reservoir and the contrasting steep slopes of the bordering dissected highland areas. It is not by accident that the existing and proposed mine areas are located near the reservoir in and adjacent to the lower reaches of the principal stream valleys where the slopes are minimal. It is here that the coal is closest to the surface and mining is most economical.

Four basic landforms are recognized in relation to the soil and plant cover (fig. 29). These are (1) riparian bottomlands underlain by alluvium, (2) mildly rolling benchlands underlain by sandy loam to clay with few large aggregates, (3) steep eroding hillsides underlain by weathered bedrock or thin gravelly soils, and (4) the high, dissected, gently sloping terrace surfaces that are generally underlain by thin soils that reach appreciable thickness only on hilltops. The vegetation on these basic landforms is discussed in section II. B. 1.

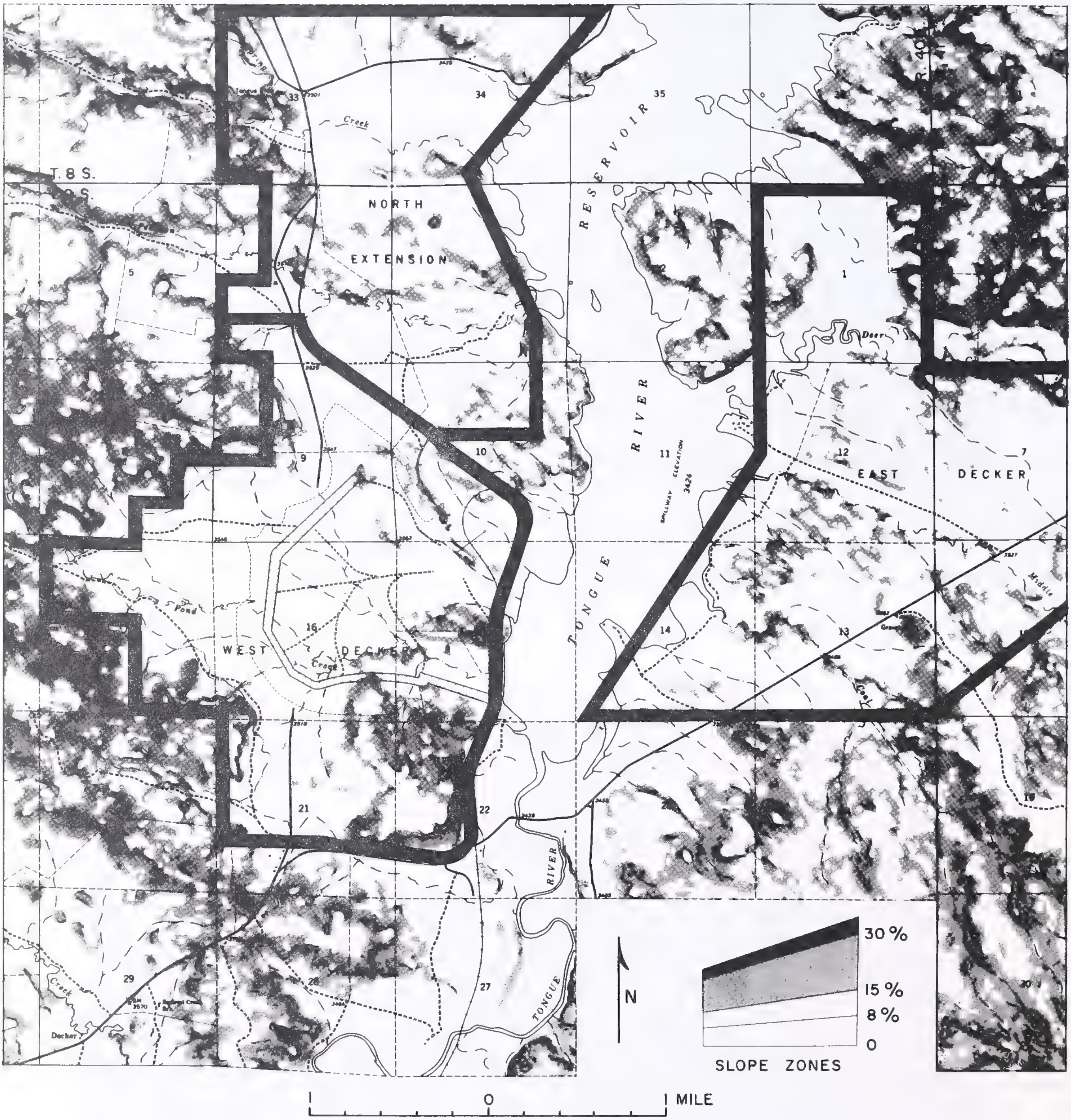
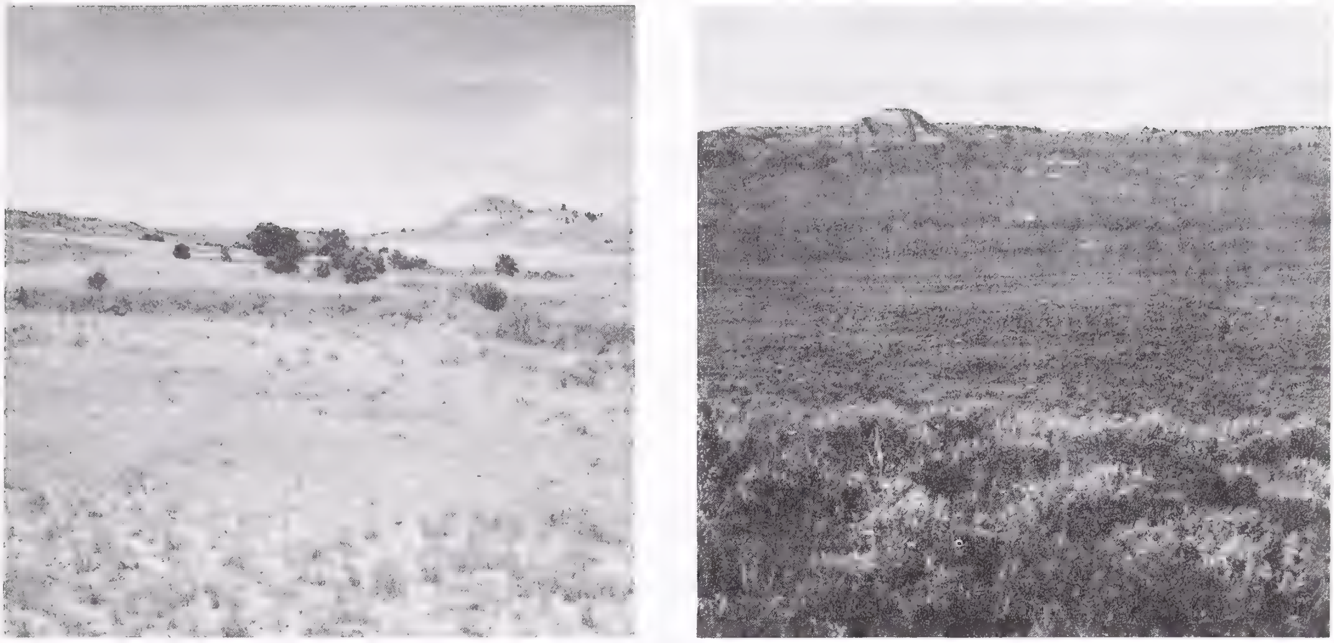
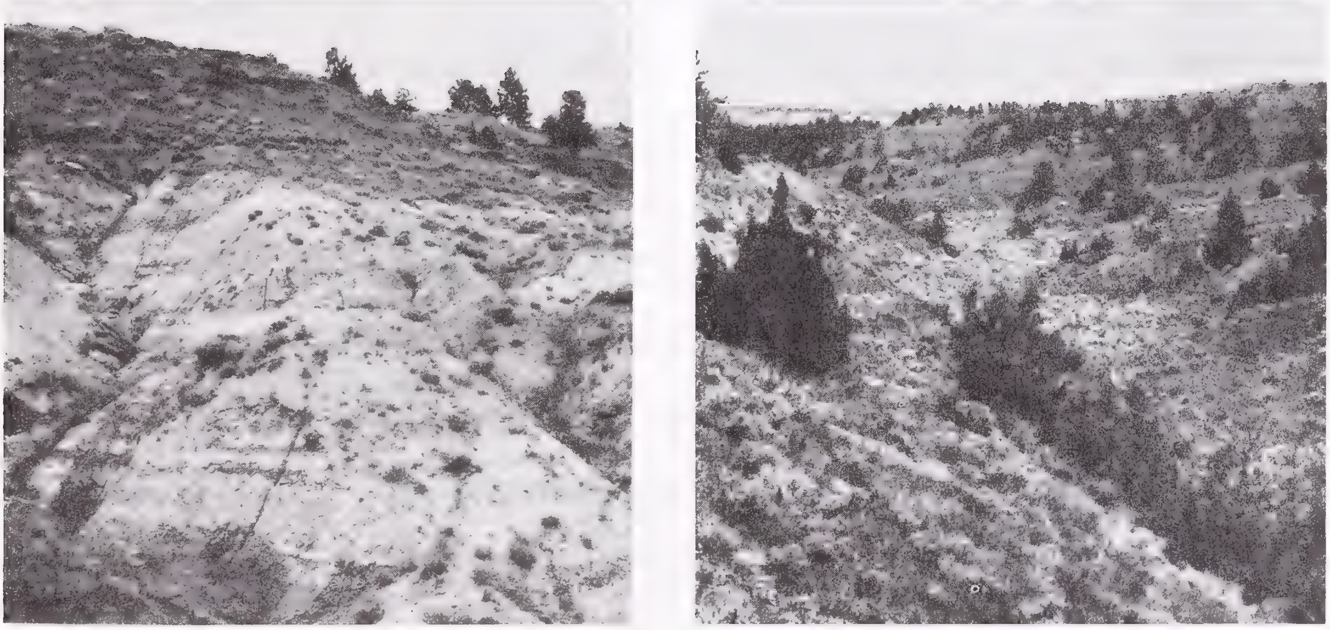


Figure 28.- Map of a part of the Decker area showing slope zones. (Prepared by the U.S. Geological Survey as an experimental map of the Decker Quadrangle).



A. Riparian bottomlands

B. Mildly rolling benchlands



C. Steep eroding hillsides

D. High, dissected terrace surfaces.

Figure 29.-Basic landforms in the Decker area in relation to the soil and to the plant cover.

4. Climate

The climate in the Decker area is the continental steppe type of the Northern Great Plains area. It is semiarid and characterized by cold winters, warm summers, and a large variation in annual and seasonal precipitation and temperature. Notable differences occur in the microclimate as a result of local changes in relief, slope and soil exposure, humidity, plant cover, and man's activities.

Wind, precipitation, and temperature patterns in this part of Montana and Wyoming are significantly affected by the mountain ranges to the west, and especially by the nearby Bighorn Mountains. The predominant air mass during the summer season is maritime Pacific, which is alternately cooled and warmed as it overrides successive mountain ranges. Thus, much of the moisture has been removed prior to reaching the area. The winters are dominated by high-pressure, cold Arctic air masses that move southward along the east front of the Canadian Rockies. Most of the area's yearly precipitation falls during late spring and early summer as moisture-laden continental tropical air masses are drawn northward from the Gulf of Mexico by the counterclockwise rotation around low-pressure centers (Cordell, 1971). Condensation occurs as the warm air rises across the high plains and is progressively cooled, creating an "upslope condition."

Climatic data have been collected by the National Weather Service continuously since 1931 at the Sheridan County Airport and at the Sheridan Field Station. Both weather stations are about 25 miles southwest of the Decker area. Daily nonrecording precipitation records have been collected by the National Weather Service almost continuously since July 1949 at the Decker Post Office. A summary of precipitation data for the Decker station is given in Appendix C. Average monthly precipitation and temperature for the two stations near Sheridan and average monthly precipitation for the Decker station are given in table 2. Other climatic data are summarized in table 3.

a. Precipitation

Table 2 shows the average annual precipitation in the Decker area to be about 25 percent less than at Sheridan, although the seasonal pattern is very similar. The following analysis, therefore, is based largely on the Decker record. For the period of record 1949-74, annual precipitation at the Decker station ranged from a low of about 6.47 inches in 1960 to a high of about 17.59 inches in 1968 (fig. 30). Average annual precipitation was 11.79 inches; median annual precipitation was 11.34 inches. About 45 percent of the annual precipitation falls in the 3-month period, April-June (fig. 31). An additional 30 percent falls mostly as snow in the 6-month period, October-March. The remainder generally occurs as summer thunderstorms, which commonly are accompanied by high winds and hail. Most flooding in the area occurs in response to high-intensity thunderstorms of comparatively short duration. Table 4 shows the maximum amount of rainfall that would be expected at any point in the Decker area for duration periods of 5 minutes to 1 day and for recurrence intervals of 2 to 100 years. Included in this table are conversion factors that can be used to relate point precipitation to precipitation on watersheds of various sizes.

In an average year, the area can expect to receive precipitation of 0.01 inch or more on 95 days, a maximum of 1.2 inches in 24 hours, and snowfall of 1 inch or more on 20 days. As indicated above, however, large deviations occur from one year to another (fig. 30). Annual precipitation of less than 10 inches has occurred in 25 percent of the years of record.

Table 2.--Average monthly precipitation and temperature for stations near Decker, Montana, and Sheridan, Wyoming
(Data from records of the National Weather Service.)

Month	Average precipitation (inches)			Average temperature (°F)	
	Decker	Sheridan Field Station	Sheridan Airport	Sheridan Field Station	Sheridan Airport
January	0.47	0.55	0.64	19.6	21.3
February	.34	.62	.74	22.4	23.8
March	.55	1.22	1.42	30.2	31.0
April	1.37	2.00	2.16	44.1	43.6
May	1.80	2.81	2.57	54.1	59.6
June	2.30	2.86	2.57	62.0	61.9
July	.93	1.41	1.19	71.6	71.3
August	1.05	.89	.90	69.8	69.5
September	1.07	1.43	1.17	58.9	58.8
October	.96	1.18	1.13	47.7	47.8
November	.49	.70	.80	32.7	33.4
December	.40	.51	.62	24.1	26.3
Year	11.79	16.18	15.91	44.8	45.2

Table 3.--Average climatic values for Decker, Montana, and vicinity for selected months.
(Data from the National Atlas, U.S. Geological Survey, 1970.)

	January	April	July	October
Mean solar radiation, langleys (gm. cal./cm^2)/day	180	500	630	300
Sunshine, hours	160	240	360	220
Mean relative humidity, percent	65	55	55	55
Mean dew point, °F	12	26	46	31
Mean temperature, °F	20	45	70	45
Mean maximum temperature, °F	30	60	85	60
Mean minimum temperature, °F	10	30	55	30

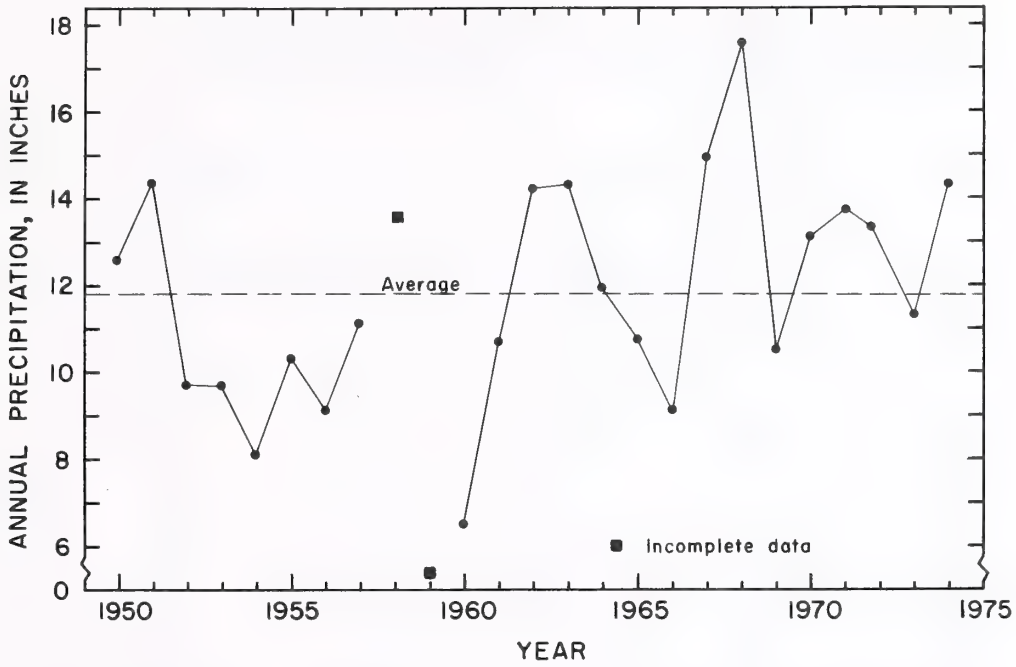


Figure 30.--Annual precipitation in the Decker area. (Data from records of the National Weather Service)

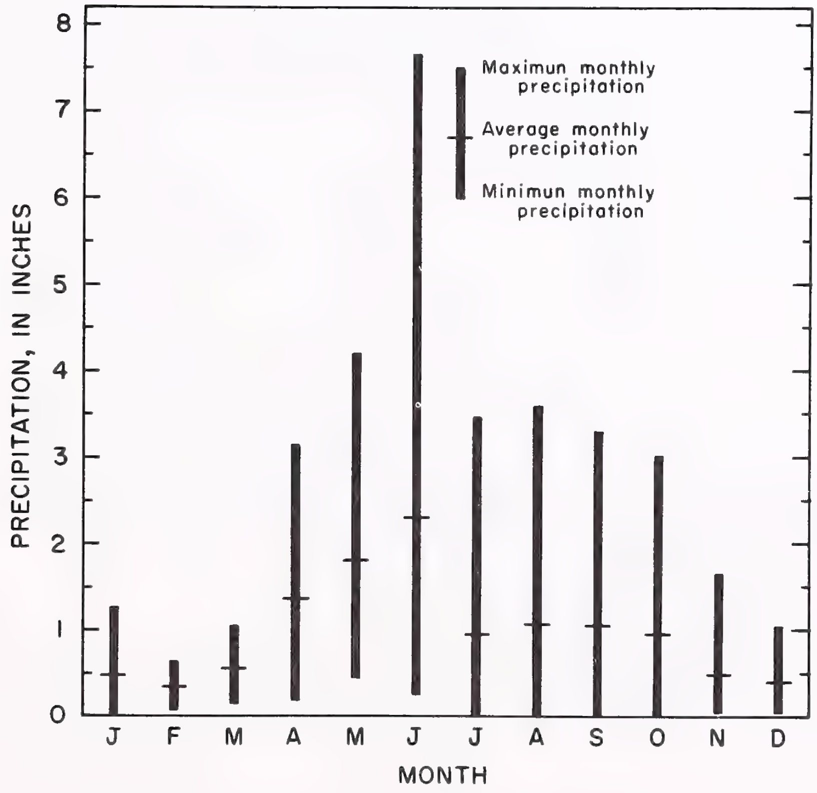


Figure 31.--Monthly range in precipitation in the Decker area. (Data from records of the National Weather Service)

Table 4.--Magnitude and Frequency of Precipitation that can be expected in the Decker area (from Miller, Frederick and Tracey, 1973)

POINT PRECIPITATION IN INCHES FOR GIVEN RECURRENCE INTERVAL IN YEARS

Duration (minutes)	Recurrence interval in years					
	2	5	10	25	50	100
5	0.19	0.28	0.32	0.41	0.47	0.55
10	.30	.43	.50	.63	.73	.85
30	.52	.75	.87	1.11	1.28	1.49
60	.66	.95	1.10	1.40	1.62	1.88
120	.75	1.04	1.20	1.55	1.76	2.01
180	.82	1.16	1.28	1.68	1.89	2.12
360	1.00	1.30	1.50	2.00	2.20	2.40
720	1.20	1.60	1.85	2.35	2.55	2.85
1440	1.40	1.90	2.20	2.70	2.90	3.30

PERCENT OF POINT PRECIPITATION THAT CAN BE EXPECTED TO FALL OVER A GIVEN AREA

Duration (minutes)	Area of watersheds in square miles				
	5	10	20	40	100
30	93	88	82	72	61
60	96	93	89	82	72
180	98	97	94	91	84
360	99	98	96	94	89
1440	99	98	97	96	93

b. Radiation

Mean solar radiation and hours of sunshine for months representative of the four seasons are given in table 3. On an annual basis, 63 percent of the maximum possible sunshine reaches the land surface (on 37 percent of the day-light hours the sun is obscurred by clouds). During the winter months, more than 50 percent of the maximum possible sunshine reaches the land surface.

c. Temperature

Seasonal and daily variations between maximum and minimum temperatures are often extreme. Daily variations of 30° to 35° F (Fahrenheit) are common as a result of characteristic low humidity and strong terrestrial radiation. Temperatures at Sheridan range from -30° to 103° F; temperatures at Birney in the Tongue River valley about 20 miles northeast of the Decker area range from -45° to 107° F. Temperatures ranges in the Decker area probably lie between these extremes. The mean, the mean maximum, and the mean minimum temperatures for January, April, July, and October are given in table 3. The growing season generally lasts 100 to 130 days. Mean annual cooling degrees (° F) days is 600 and mean annual heating degree days is 7,500.

d. Wind

Wind direction is modified by the Bighorn Mountains to the west such that the prevailing westerlies are deflected southeastward across the area. Locally, surface winds are affected by topographic highs and some wind channeling may occur along stream valleys. No wind direction or velocity data have been collected in the Decker area. Average wind velocity at the Sheridan airport is 8 miles per hour; however, velocities in excess of 25 miles per hour are common throughout the year. Hot dry winds commonly blow during the summer, and strong winds accompanying snowstorms often cause drifting and ground blizzards in the winter. Highest wind velocities, however, probably occur during summer thunderstorms. Thermally induced diurnal upvalley and downvalley flows may occur when other pressure gradients are small.

e. Evaporation

Evaporation is controlled primarily by temperature, solar radiation, relative humidity, and wind velocity. Data from the National Atlas (U.S. Geological Survey, 1970) show the mean annual evaporation from a Class A pan in this general area to be about 55 inches per year. Gross evaporation from reservoirs and evaporation ponds, therefore, should be about 40 inches of water per year (Todd, 1970, p. 91). Net evaporation after adjustment for annual precipitation should be about 28 inches of water per year. About 77 percent of this evaporation occurs during the 6-month period, May to October. Mean relative humidity and dew point for January, April, July, and October are given in table 3.

5. Air Quality

The following description of the existing ambient air quality in the Decker area is based largely on the results of monitoring conducted by the Montana Department of Health and Environmental Sciences, Air Quality Bureau. Results of that monitoring were summarized by David Maughan of the Air Quality Bureau and furnished to the Department of State Lands as a written communication dated January 17, 1977. Unless otherwise referenced, all material presented on air quality is based on the information furnished by David Maughan in that written communication.

a. General setting

Both the proposed East Decker and North Extension mine sites are in shallow topograhic basins formed by the juncture of ephemeral stream valleys with the Tongue River. The potential for air pollution in these basins depends largely on the mixing heights in the air mass and on average wind speeds in the mixing layers. Pollution dispersion is enhanced by lofty mixing heights and high wind velocities and inhibited by shallow mixing heights and low wind velocities. Estimated annual average mixing heights in the Decker area range from about 1,000 feet in the morning to 6,500 feet in the afternoon, with respective wind velocities of 11 miles per hour and 16 miles per hour through the layer (U.S. Environmental Protection Agency, 1972).

Because of the dry air and rapid terrestrial radiation, shallow basins in the Decker area frequently experience low-level nocturnal temperature inversions, especially during the winter months. These inversions normally dissipate during the morning hours as temperature and wind velocity increase. Should surface-based inversions persist for extended periods, however, pollutants trapped within the shallow basins tend to accumulate, and high ground-level pollutant concentrations may occur.

The existing air quality in the Decker area is typical of rural or rangeland areas in that particulate levels are closely related to rainfall patterns. Generally, total suspended particulate (TSP) levels tend to be highest during the dry summer and fall months. An inverse correlation normally exists between TSP levels and rainfall, and a direct correlation normally exists between TSP levels and wind speed.

During periods of extended drouth, high humidity, or high winds, visibility may be reduced in the proposed mine areas and TSP levels in excess of several hundred ug/m^3 may occur (U.S. Department of Interior, 1974).

Prior to the onset of mining in the area, air pollutants, typically consisted largely of fugitive dust from unimproved or clinker-surfaced roads, cultivated fields, barren slopes, and overgrazed sites. Gaseous emissions were minimal and presented no pollution problems. With the advent of mining at the West Decker mine in 1972 and the increase in production to about 10 million tons of coal in 1976, fugitive dust and dust emissions have increased significantly in the proximity of the mine. Gaseous emissions have also increased slightly.

b. Monitoring stations

In 1972 when surface disturbances began in conjunction with opening the West Decker mine, the Montana Department of Health and Environmental Sciences installed a high-volume (hi-vol) sampler to monitor particulates at the Carlat Ranch on the east side of the Tongue River Reservoir, which is generally down wind from the West Decker mine (fig. 70A). This station was operated from fall 1972 until spring 1974 (table 4A and table C-4). During this period, total suspended particulates did not exceed maximum levels permitted by State and Federal standards. Accordingly, the station was moved in 1974 to the old Thomas Ranch on the west side of the Tongue River Reservoir adjacent to the West Decker mine (fig. 70A). Monitoring of total suspended particulates is continuing at that location, which is referred to as the Morton station.

Table 4A.--Total suspended particulate readings in the Decker area (data from records of Air Quality Bureau, Montana Department of Health & Environmental Sciences)

	Quarterly geometric averages in ug/m^3					
	Carlat station [1]			Morton station [1]		
	1972	1973	1974	1974	1975	1976
First quarter	--	6.9	10.3	--	33.3	53.7
Second quarter	--	19.7	--	--	--	64.6
Third quarter	--	28.7	--	--	--	97.3
Fourth quarter	9.2	20.5	--	54.3	34.6	69.2[2]
Annual	--	15.4	--	--	--	70.2

[1] See figure 70A for location.

[2] Two and one-half months data.

In addition to monitoring particulates at the two stations described above, the Air Quality Bureau also measured ambient sulfurous gas concentrations at the West Decker mine and at the Decker Post Office during the period May 1972 through December 1973. Measurements were made using a sulfation plate.

The Montana State University also conducted a cursory program of air-quality monitoring in the Youngs Creek area about eight miles west of the Decker area during the period 1973-74. Suspended particulates, settleable dust, and sulfur dioxide were monitored during that brief study (Sindelar, 1974).

c. Established air-quality standards

Montana ambient air-quality standards relevant to studies in the Decker area are listed in table 5. National ambient air-quality standards are listed in table 6.

The entire United States is currently designated as class II air-quality area by the U.S. Environmental Protection Agency (EPA). A class II designation allows a maximum increase in a given area of 10 micrograms per cubic meter of air (ug/m^3) in total suspended particulates (TSP) above the TSP concentration that represents the geometric average within that area in 1974. The 1974 average is the baseline against which future changes in air quality are to be measured.

No complete record was obtained at either the Carlat or Morton stations in 1974. The 1973 annual geometric average at the Carlat station, however, was only 15.4 ug/m^3 of air. Background[1/] TSP levels for the Decker area also can be approximated from data collected at nine TSP monitoring stations operated by the Air Quality Bureau in relatively undisturbed areas in eastern Montana. The 1976 range in geometric mean for these stations was 15.7-31.8 ug/m^3. The average 1976 geometric mean for TSP was 21.2 ug/m^3. On that basis, the Decker area as a whole should have a background or baseline TSP level of about average or about 20 ug/m^3. If so, the maximum allowable average geometric mean TSP in the Decker area would be about 30 ug/m^3 under existing EPA class II air-quality standards.

[1/] See glossary for definition of background.

Table 5.--Selected Montana ambient air-quality standards (Montana Department of Health and Environmental Sciences, 1967)

Pollutants	Standards
Particulates	
Total suspended	75 ug/m^3 - annual geometric mean
	200 ug/m^3 - not to be exceeded more than 1% of days/year.
Settled (dustfall)	15T/mi^2/mon - 3-month average residential
	30T/mi^2/mon - 3-month average industrial
Sulfur oxides	
Sulfur dioxide	0.02 ppm - maximum annual average
	0.10 ppm - 24-hour average not to be exceeded over 1% of days/3 months
	0.25 ppm - not to be exceeded more than 1 hour/4 consecutive days
Suspended sulfate	4 ug/m^3 - maximum annual average
	12 ug/m^3 - not to be exceeded over 1% of time
Reactive sulfur (sulfation)	0.25 mg SO_3/100cm^2/day - maximum annual average
	0.50 mg SO_3/100cm^2/day - maximum for any 1-month period

ug/m^3 = micrograms per cubic meter of air
T/mi^2/mon = tons per square mile per month
ppm = parts per million

Table 6. -- National ambient air-quality standards (U.S. Envirnomental Protection Agency, 1971)

	Pollutant	Primary standard[1]	Secondary standard[2]
1.	Sulfur oxides	80 ug/m^3 (0.03 ppm) annual arith. mean 365 ug/m^3 (0.14 ppm) max 24 hr conc. not to be exceeded more than once a year.	1,300 ug/m^3 (0.5 ppm) max 3 hr conc. not to be exceeded more than once a year.
2.	Particulate	75 ug/m^3 annual geom. mean 260 ug/m^3 max 24 hr conc. not to be exceeded more than once a year.	60 ug/m^3 annual geom. mean[3], 150 ug/m^3 max 24 hr conc. not to be exceeded more than once a year.
3.	Carbon monoxide	10,000 ug/m^3 (9 ppm) max 8 hr conc. not to be exceeded more than once a year.	Same as primary.
		40,000 ug/m^3 (35 ppm) max 1 hr conc. not to be exceeded more than once a year.	Same as primary.
4.	Photo chemical oxidants(corrected for NO_2 and SO_2) interference.	100 ug/m^3 (0.08 ppm) max 1 hr conc. not to be exceeded more than once a year.	Same as primary.
5.	Hydrocarbons (corrected for CH_4)	160 ug/m^3 (0.24 ppm) max 3 hr conc. (6 to 8 a.m.) not to be exceeded more than once a year.	Same as primary.
6.	Nitrogen oxides (as nitrogen dioxide)	100 ug/m^3 (0.05 ppm) annual arith. mean.	Same as primary.

[1] Primary air-quality standards were established to protect health.

[2] Secondary air-quality standards were established to protest aesthetic values.

[3] To be used as guide in assessing State implementation plans.

It should be noted that the standards for "prevention of significant air-quality deterioration" (PSD) set forth in the Federal Register, Volume 34, No. 235, December 5, 1974, preclude 19 specific source categories of air pollution from locating in an area if the maximum allowable TSP levels have been exceeded. Surface coal mines are not included in those categories, however, and would not require review by EPA prior to their location.

d. Results of monitoring

(1) Particulates

Total suspended particulates (TSP) are measured by passing air through high volume (hi-vol) air filters at a calibrated rate.

Data from the Carlat Ranch hi-vol station for the period 1972-74 indicate that TSP levels were less than State and Federal maximum standards (table 4A and table C-4, Appendix C). The annual geometric mean for 1973, the only full year of data for the Carlat station, was 15.4 micrograms per cubic meter (ug/m^3) of air. These low readings were recorded despite the fact that the station was only about 2½ miles northeast of the West Decker operation and undoubtedly was downwind at times from the ongoing mine activities. During the 1972-74 period, coal production from the West Decker mine was approximately 5-6 million tons per year. TSP data recorded at the Carlat station, when compared to those for other eastern Montana "background" stations indicate that the Carlat station was also "background" with regards to particulate levels.

TSP measurements during the Youngs Creek study were similar in magnitude to those at the Carlat station. At Youngs Creek an annual geometric mean of 13 ug/m^3 and a 24-hour maximum of 56 ug/m^3 were reported by Sindelar (1974).

TSP data from the Morton hi-vol station, which is located less than half a mile from the West Decker mine, show a geometric mean of about 40 ug/m^3 and a 24-hour maximum of 160 ug/m^3 for the October 1974-February 1975 period. During this period when annual coal production approached 8.5 million tons, TSP levels still complied with State and Federal standards. During 1976, however, coal production at the West Decker mine increased to approximately 10 million tons per year, and TSP concentrations at the nearby Morton station increased substantially. The 1976 annual geometric mean was 70 ug/m^3, which closely approached the maximum of 75 ug/m^3 permitted by State and primary Federal standards (tables 5 and 6). On five occasions during 1976, the 24-hour TSP concentrations at the Morton station exceeded 200 ug/m^3 (table C-5, Appendix C). This violates State air-quality standards which permit the level of 200 ug/m^3 to be exceeded no more than one percent of the days per year. The Montana Department of Health and Environmental Sciences is in the process of issuing a citation for that violation (Michael Roach, Chief, Air Quality Bureau, oral communication, January 31, 1977).

Decker Coal Co. officials state that the increased TSP concentrations at the Morton station can be attributed largely to accelerated reclamation work with scrapers in the mine area adjacent to the station. Available data, however, indicate that, although the use of the scrapers was greatly curtailed about the end of August, the TSP geometric mean for the period October 1-December 14, 1976[1/] was 69.2 ug/m^3 (table 4A). The logical conclusion, therefore, is that the increased TSP levels must be attributed

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[1/] Data for the entire quarter are not available. Weekly TSP readings were taken during the period October 3 - December 14, 1976 (table C-2, Appendix C).

largely to factors other than the nearby reclamation activities. The most important of these factors are probably the significant increase in coal production at the West Decker mine and the substantially reduced precipitation in 1976 compared to that in 1975. As previously stated, an inverse relationship generally exists between precipitation and TSP levels.

(2) Sulfurous gases

Measured sulfation rates in 1972 and 1973 at the Decker Post Office and the Decker mine are listed in the following table. These data indicate that sulfation rates in the Decker area during this period were well below the maximum limits permitted by Montana ambient air-quality standards (table 5).

Location	Annual sulfation rate[1/] (mg/100 cm^2/day		Maximum monthly sulfation rate[2/] (mg/100 cm^2/day	
	1972	1973	1972	1973
Decker Post Office	0.064	0.012	0.14	0.08
Decker Mine	0.041	0.012	0.15	0.08

[1/] Average of 8 samples.
[2/] Average of 12 samples.

(3) Other air pollutants

Air-quality monitoring to date in the Decker area has not included pollutants other than particulates and sulfurous gases. Results of extensive air-quality monitoring in the Colstrip area, however, indicate that only background levels would be expected in the Decker area for all air-quality parameters except particulates (TSP), which is dicussed above, and ozone and hydrocarbons.

(a) Ozone

Ozone concentrations in the Decker area should be generally similar to those in the Colstrip area prior to operation of electric power generation plants in that area. Concentrations monitored at Colstrip occasionally exceeded the maximum level of 0.08 parts per million (ppm) on a 1-hour basis permitted by National standards. Such concentrations have also been recorded in many higher elevations in the United States. Accordingly, maximum ozone concentrations approaching maximum permitted levels can be expected occasionally in the Decker area.

(b) Hydrocarbons

Methane concentrations of 1-2 ppm prevail at Colstrip and are comparable to background levels in other remote areas. A number of large diesel-powered vehicles or railroad engines in a small area could cause local violations of National ambient air-quality standards for hydrocarbons (table 6). At least 20-30 such vehicles would be necessary in a small area, however, to significantly increase hydrocarbon levels beyond the background level. Those conditions are not known to exist currently in the Decker area.

6. Geology

a. Stratigraphy and structure

The geology of the Decker area has been described by Baker (1929), Matson and Blumer (1973), and Law and Grazis (1973). The summary below is based largely on these reports and on data furnished by the Decker Coal Co.

The Decker area lies near the northwest margin of the Powder River Basin, a large structural depression in the earth's surface that has been filled with sedimentary formations ranging in age from Holocene to Cambrian (table 7). In the Decker area, these formations have an aggregate thickness of about 12,000 feet. The uppermost bedrock unit is the Wasatch Formation of Eocene age, a sequence of interbedded claystone, shale, siltstone, sandstone, and thin coal beds that crop out in the Badger Hills in the southeastern part of the area (fig. 32). Underlying the Wasatch Formation is the Fort Union Formation of Paleocene age, a sequence of interbedded sandstone, siltstone, shale, and coal beds that forms the bedrock throughout most of the Decker area. The Fort Union Formation is locally about 3,400 feet thick, but only the upper 1,600 feet, called the Tongue River Member, contains thick coal beds of economic interest.

The Tongue River Member in this general area contains about 9 persistent coal beds 5 to 35 feet thick, and perhaps an equal number of thin, less persistent beds. Most of the thick beds are continuous over broad areas; some underlie hundreds of square miles. Figure 33 shows the position, thickness, and names of the principal coal beds in the Tongue River Member.

The thickness of the interburden between coal beds often changes appreciably from place to place, varying as much as 100 feet over a distance of a mile. Although the interburden deposits separating the three coal beds to be mined in this area (the Anderson, Dietz 1, and Dietz 2 coal beds) vary locally in thickness, they also exhibit an areal trend. As illustrated in the cross sections (fig. 34), the combined thickness of the

Table 7.--Sedimentary rock units underlying the Decker area, Mont.

[Descriptions and thickness derived in part from Law and Grazis (1973) and from the American Stratigraphic Co. sample log of Shell Oil Co. Buszkiewic No. 1 sec. 30, T. 58 N., R. 84 W., Sheridan County, Wyo.]

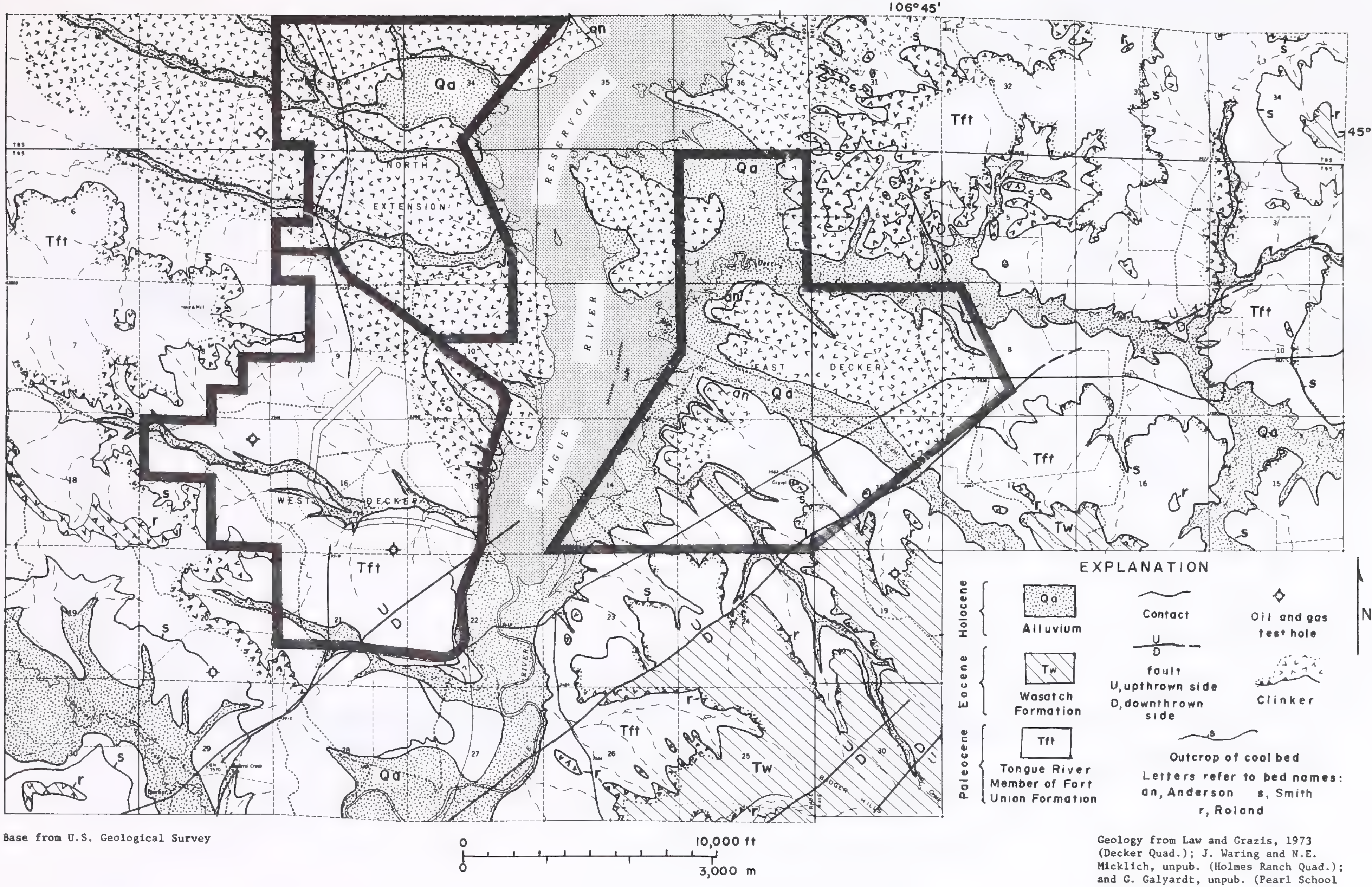
Erathem	System	Series	Formation	Thickness (ft)	Lithology	Water-bearing characteristics
Cenozoic	Quaternary	Holocene	Alluvium	up to 80	Unconsolidated poorly stratified clay, sand, and gravel deposited in stream valleys	May yield as much as 500 gal/min to irrigation wells in the Tongue River valley.
		Pleistocene (?)	Terrace deposits	up to 20	Gravel beds 2-20 ft thick consisting primarily of sand, chert, quartzite, limestone, dolomite, granite, diabase, and metamorphic pebbles and cobbles as much as 1 ft thick. Commonly cap small terraces near the Tongue River	Most terraces are small in areal extent, topographically high, and generally drained of water. Seeps occur locally on steep slopes where the base of the terrace deposits is exposed.
	Tertiary	Eocene	Wasatch	400	Interbedded soft clay, shale, siltstone, and sandstone, several thin coal beds, and numerous thin beds of molluscan fossils. Locally contains thick beds of clinker (baked or fused sandstone or shale)	Most wells are shallow and yield less than 20 gal/min. Dissolved solids commonly range from 500 to 3,000 mg/l. Sodium, bicarbonate and sulfate are the dominant ions.
		Paleocene	Fort Union:			
			Tongue River Member	1,600	Interbedded sandstone, siltstone, and shale, numerous thick and thin coal beds, several thin beds of molluscan fossils, and several zones of abundant silicified wood. Locally contains thick beds of clinker (baked or fused sandstone or shale)	Coal beds generally yield less than 20 gal/min of soft, iron-free water. Sandstones yield up to 50 gal/min of highly mineralized, sodium-rich water. Clinker is highly permeable, but is commonly dry owing to high topographic position.
			Lebo Shale Member	1,250	Dark-gray mudstone and claystone, contains abundant ferruginous concretions and a few lenticular beds of light-gray sandstone. Locally contains one or more coal beds	Not known to yield water in the Decker area.
			Tullock Member	550	Light-gray calcareous sandstone, gray sandy and silty shale, and a few thin beds of coal and coaly shale	Sandstone and coal beds should yield small to moderate amounts of sodium-rich water.
Mesozoic	Cretaceous	Upper Cretaceous	Hell Creek	650	Gray and greenish-gray shale, and light-gray, fine-grained sandstone, with traces of coal and coaly shale. Also called Lance Formation	Basal Hell Creek - Fox Hills aquifer might yield as much as 500 gal/min. Artesian head should be above land surface in low areas. Water probably is a sodium bicarbonate type and may contain as much as 1,500 mg/l dissolved solids.
			Fox Hills Sandstone	200	Light to very light gray sandstone and gray to grayish green shale and sandy shale	

Table 7.--Sedimentary rock units underlying the Decker area, Mont. (Continued)

Erathem	System	Series	Formation	Thickness (ft)	Lithology	Water-bearing characteristics
			Bear Paw Shale	270	Gray to dark-gray bentonitic shale and sandy shale, a few thin beds of light-gray bentonite, and dark-gray argillaceous sandstone	Sandy zones may yield as much as 10 gal/min of highly mineralized water, but most of the formation is not water bearing.
			Parkman Sandstone	620	Light-gray, fine-to-coarse-grained sandstone, gray to dark-gray shale, minor beds of carbonaceous shale, and traces of coal	Yields of as much as 50 gal/min are possible. Dissolved solids can be expected to range from 500 to 2,000 mg/1.
			Cody Shale	2,800	Gray, dark-gray, and gray-green shale, minor gray fine-grained glauconitic sandstone, and thin beds of bentonite. Contains the Shannon Sandstone in the upper part, and Niobrara, Carlile, and Belle Fourche Shales in lower part	Shannon sandstone member might yield as much as 20 gal/min of sodium-sulfate water with a dissolved solids content in excess of 1,000 mg/1. Remainder of formation is probably not water bearing.
		Lower Cretaceous	Mowry Shale	400	Dark-gray siliceous shale containing thin beds of bentonite and thin beds of dark-gray or gray-green argillaceous sandstone and siltstone	Sandy zones might yield some mineralized water to a well, but the formation generally is not water bearing.
			Newcastle Sandstone	50	Gray to gray-brown fine-grained argillaceous sandstone interbedded with a few beds of dark-gray shale. Also called Muddy Sandstone	Sandstone beds might yield as much as 10 gal/min, but other rocks probably are not water bearing.
			Skull Creek Shale	90	Dark-gray shale, bentonitic in part	Probably not water bearing.
			Fall River	200	Gray bentonitic shale, gray to dark-gray argillaceous siltstone and very fine grained sandstone	Should yield 10 to 20 gal/min; yields in excess of 100 gal/min may be possible. Dissolved solids are expected to range from 1,000 to 3,000 mg/1.
			Lakota	180	Light-gray, gray-green, and reddish-brown claystone, containing beds of light-gray fine- to coarse-grained sandstone in lower half	
	Jurassic		Morrison	150	Maroon, green, and gray claystone, calcareous in part, containing beds of light-gray very fine grained calcareous sandstone, or sandy limestone, in lower part	Sandy zones may yield as much as 10 gal/min but most of the formation probably is not water bearing.
			Sundance	220	Gray to gray-green shale, sandy in part, interbedded with light-gray glauconitic calcareous sandstone	Sandstone beds may yield up to 20 gal/min of moderately mineralized water.

Table 7.--Sedimentary rock units underlying the Decker area, Mont. (Continued)

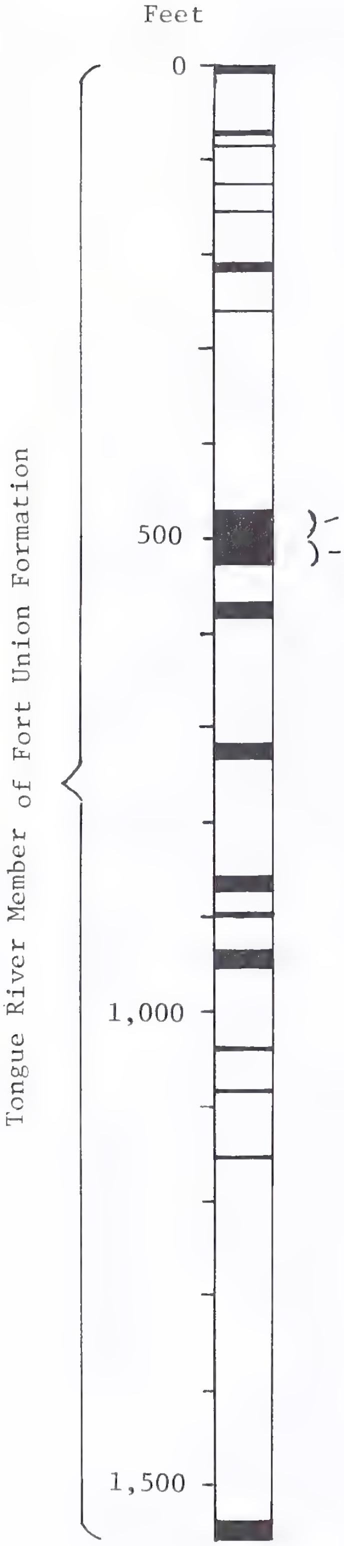
Erathem	System	Series	Formation	Thickness (ft)	Lithology	Water-bearing characteristics
			Piper Limestone	40	Brown to dark-brown limestone, oolitic in part	May yield a few gallons per minute from solution cavities.
			Underlying Jurassic rocks	230	Green and reddish claystone in upper part, beds of tan dolomite and limestone in middle and orange-red shale interbedded with gypsum and anhydrite in lower part	Not known to be water bearing.
	Triassic		Chugwater	350	Orange-red very fine grained sandstone, dolomitic in part, interbedded with reddish-brown or orange-red shale and siltstone	May yield as much as 20 gal/min of moderately to highly mineralized calcium-sulfate water.
Paleozoic	Permian		Goose Egg	170	Orange-red sandy shale and very fine grained sandstone and pink to white gypsum and anhydrite	Probably will yield little or no water.
	Pennsylvanian		Tensleep Sandstone	190	Very light gray to pink fine-grained sandstone, dolomitic in part, light-gray to purple dolomite and sandy dolomite, with minor maroon shale	May yield as much as 1,000 gal/min. Dissolved solids might be less than 1,000 mg/1. Water should be a calcium-bicarbonate type.
			Amsden	120	Light-gray to pink cherty dolomite and reddish limestone in upper 80 ft; orange-red fine- to coarse-grained gypsiferous sandstone in lower 40 ft	May yield 20 to 200 gal/min from solution cavities.
	Mississippian		Madison Limestone	800	Light-gray and brownish bioclastic dolomite and minor limestone, contains one bed of anhydrite	The Madison Limestone - Bighorn Dolomite interval may comprise a single hydrologic unit. Yields in excess of 1,000 gal/min should be available from solution cavities. Water is under sufficient artesian pressure to flow at the land surface. Dissolved solids may range from 1,000 to 2,000 mg/1.
	Devonian		Duperow	70	Light-gray, tan, and pinkish dolomite, and a few thin beds of siltstone and shale	
	Silurian		Interlake	40	Light-gray to tan fragmented dolomite	
	Ordivician		Bighorn Dolomite	420	Light-gray to tan sucrose dolomite	
			Winnipeg Sandstone	est. 60	Light-gray very fine to coarse grained quartzite sandstone	Probably will yield little or no water.
	Cambrian		Cambrian rocks undivided	30	Not penetrated by wells in this area. To north about 30 ft of limestone and shale are assigned to the Cambrian	Probably will yield little or no water.



Base from U.S. Geological Survey

Geology from Law and Grazis, 1973 (Decker Quad.); J. Waring and N.E. Micklich, unpub. (Holmes Ranch Quad.); and G. Galyardt, unpub. (Pearl School Quad.).

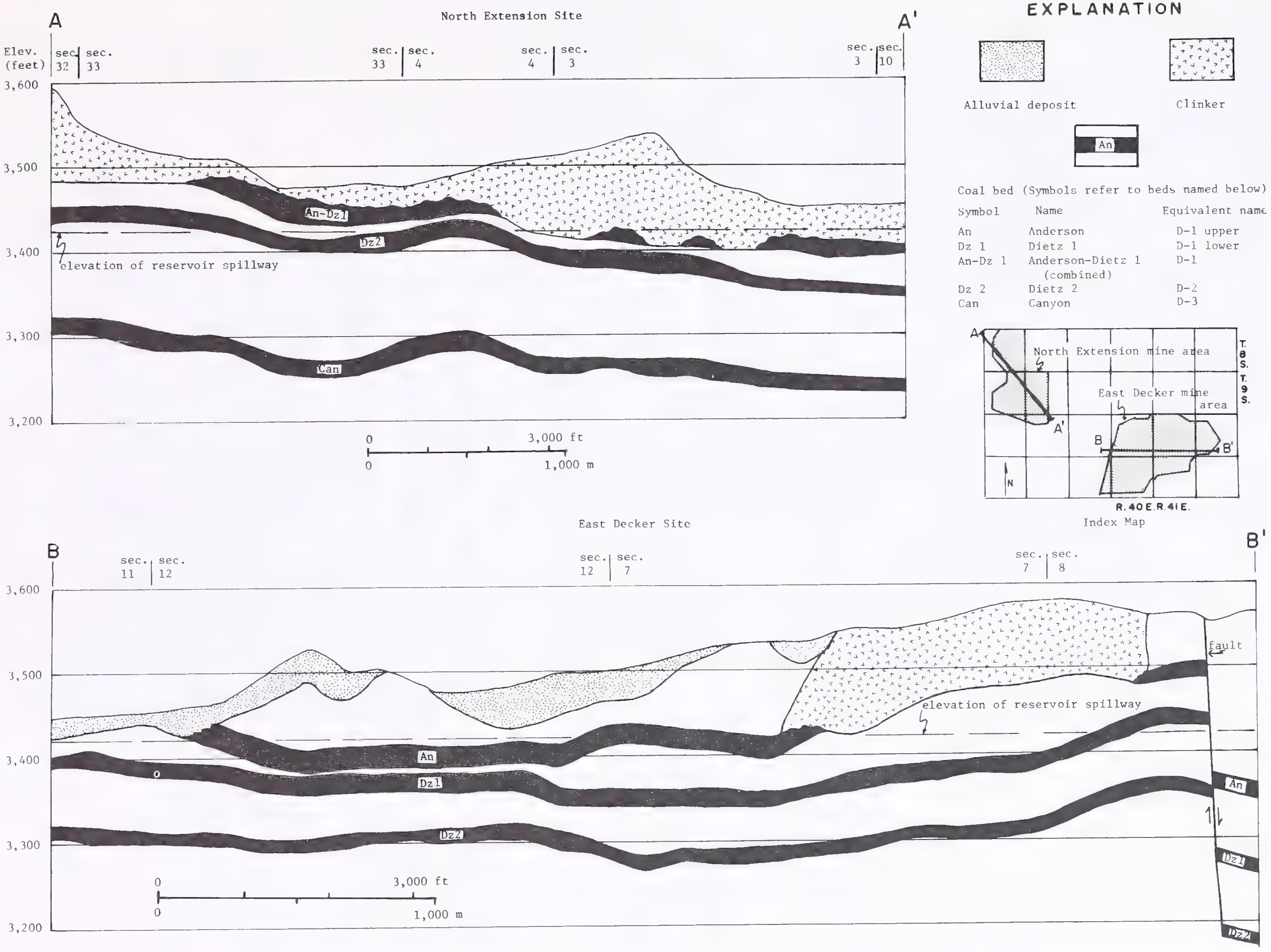
Figure 32.- Geologic map of the Decker area, Big Horn County, Montana.



*Name	Thickness range (ft)	Decker Coal Co. names
Roland coal	8-12	
Squirrel Creek coal	2-5	
Smith coal	7-26	
Anderson coal	15-35	D-1 upper coal
Dietz 1 coal	10-22	D-1 lower coal
Dietz 2 coal	12-28	D-2 coal
Canyon (or Monarch) coal	14-22	D-3 coal
Wall (or Carney) coal	11-28	
A coal	5-20	
D coal	8-16	

*(from Matson and Blumer 1973, Law and Grazis, 1973)

Figure 33.--Generalized columnar section of the Tongue River Member of the Fort Union Formation showing position, thickness, and names of the principal coal beds in the Decker area.



Symbol	Name	Equivalent name
An	Anderson	D-1 upper
Dz 1	Dietz 1	D-1 lower
An-Dz 1	Anderson-Dietz 1 (combined)	D-1
Dz 2	Dietz 2	D-2
Can	Canyon	D-3

Figure 34.- Cross sections through the proposed mine areas, Decker area, Montana.

coal and interburden in the eastern part of the Decker area is about 200 feet. Westward, the Anderson coal and the Dietz 1 coal coalesce to form a single bed about 52 feet thick, which is currently being mined at the West Decker mine. About 2 miles further west, the Dietz 2 coal coalesces with the Anderson-Dietz 1 coal to form one bed about 80 feet thick. This coalescence has hampered correlations with prominent coal beds to the south near Sheridan, Wyo. As a result, no general agreement exists as to the correct nomenclature in the Decker area. Moreover, only informal names have been assigned to coal beds below the Wall coal in this general area because these beds have been identified only from interpretation of logs and sample cuttings from oil and gas test wells.

In addition to the coal beds, the Tongue River Member consists of interbedded gray to cream-colored, fine-grained sandstone, sandy shale, siltstone, and brownish carbonaceous shale. Most of these rocks are poorly cemented and weather readily to form slopes; a few of the sandstone beds, however, are well cemented and form ledges. A thick, poorly cemented sandstone bed below the Smith coal locally weathers to form a picturesque badlands topography. The Tongue River Member commonly contains stumps or logs of petrified wood and fossilized mollusk shells.

Because most clastic beds in the Tongue River Member were deposited on flood plains of large rivers, in river and stream channels, or on deltas extending outward into swamps, they tend to be lenticular in shape and limited in areal extent. As a result, the lithology or character of the rocks often changes rapidly over short distances, making it difficult to characterize the exact lithology of the overburden or the interburden for the whole of the Decker area.

In general, where the Anderson and Dietz 1 coal beds are unburned, they are overlain by sandy shale interbedded with varying amounts of clayey siltstone and sandstone. The Dietz 2 coal bed, according to core holes from the East Decker area, is directly overlain by about 20 feet of carbonaceous shale, which in turn is overlain by sandy shale and sandstone.

A prominent rock type in the overburden is clinker, also called scoria, red shale, burned shale, lava rock, porcellainite, nonvolcanic glass, or red dog, which occurs in shades of red, brown, yellow, and gray. Clinker is formed by the natural burning of coal beds, the heat from which either bakes or fuses the overlying strata, depending on the thickness of the coal and the rate of burning. The baked rock has a hard brick-like appearance and generally is characterized by extreme fracturing and consequent moderate to high permeability. The fused rock often resembles porous lava (fig. 35) and is highly permeable. The transition from baked to fused clinker is often abrupt, and in outcrop the fused rock appears to represent local vent areas where burning was accelerated by circulation of air through collapse fissures.

Both baked and fused clinker are resistant rock types that cap many of the hills and ridges in the area and are easily recognized by the hummocky terrain and characteristic reddish color. Clinker formed by the burning of the Anderson coal, or the combined Anderson-Dietz 1 coal, is as much as 135 feet thick and underlies the surface of much of the North Extension and some of the East Decker mine areas (figs. 32 and 34). The Dietz 1 coal bed is burned only in small areas adjacent to the outcrop in the East Decker area; the Dietz 2 coal bed is unburned.

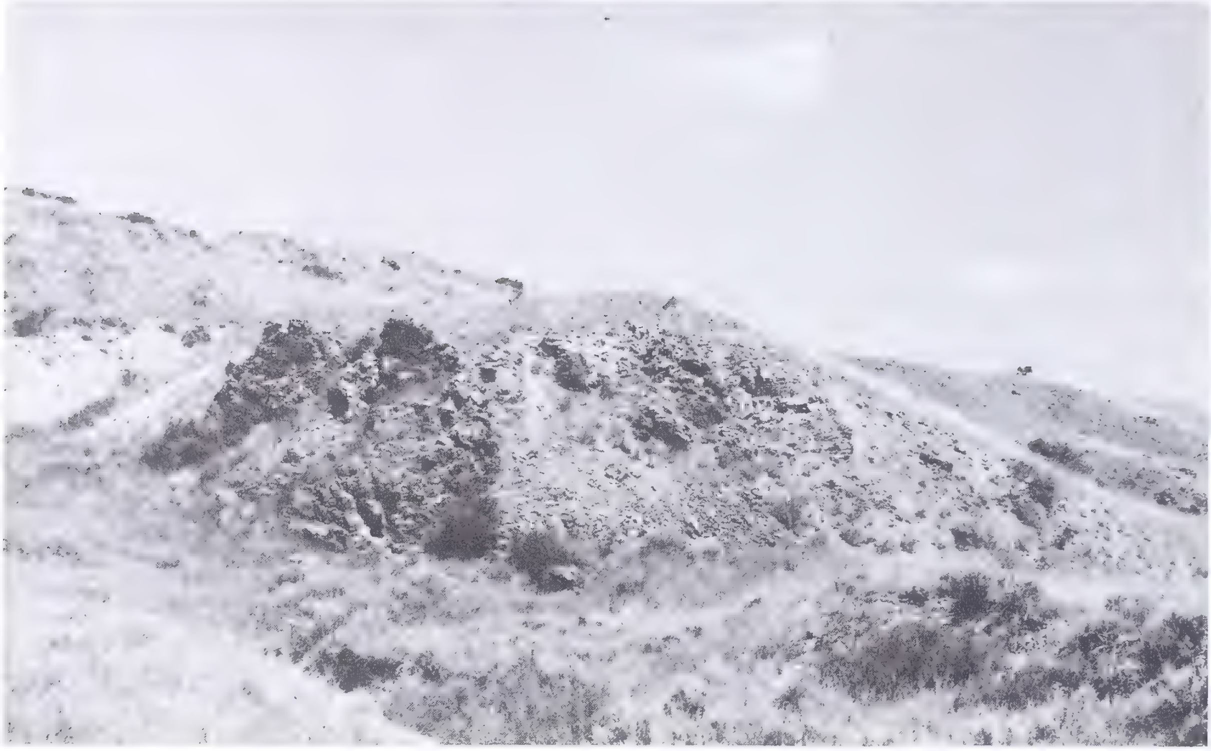


Figure 35.-Outcrop of fused clinker in the North Extension area. Note the abrupt transition from fused to adjacent baked clinker.

Samples of overburden from 17 core holes drilled in the East Decker and North Extension areas (fig. 38) were analyzed[1] to determine the suitability of these materials for plant growth if during reclamation they are buried within rooting depth of the surface. Results of these analyses are given in table B-1 (Appendix B). This table shows that the sodium adsorption ratio (SAR) varies greatly within the overburden, with values ranging from about 2 to 120.[2] Although carbonaceous shales appear to have the highest values, variations in SAR seem to be more closely related to depth below the surface than to rock type. The near surface rocks to depths of as much as 100 feet generally have SAR's of less than 18; the deeper rocks generally have values higher than 18. This relationship probably can be attributed to leaching of sodium from the near surface rocks by downward percolation of ground water. The toxicity on grazing animals of those plants containing abnormally high concentrations of toxic elements generally has not been established.

The samples of overburden were also analyzed for selected trace elements to detect the presence of any potentially toxic elements in abnormally high concentrations. Analytical methods were designed to measure only the plant-extractable amounts[3] of each reported element--not the total amount of each element present in the sample. The plant-extractable amount of an element is the amount of that element that will enter into solution under normal soil conditions and can be absorbed by plants. Results of analyses of those samples from overburden above the lowermost coal bed to be mined are summarized in table 8 (see table B-1, Appendix B for results of analyses of individual samples).

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[1] Analyses of samples from the East Decker area were made by Northern Testing Laboratories, Billings, Montana; analyses of samples from the North Extension area were made by Front Range Environmental Lab., Fort Collins, Colorado.

[2] SAR values below 12 indicate no adverse effect on plants. SAR values between 12 and 18 indicate a possible sodium problem. SAR values above 18 indicate a probable sodium problem (see discussion p. B-2, Appendix B).

[3] This procedure and method of reporting is consistent with standards accepted by the Montana Department of State Lands.

Clinker, which makes up a large part of the overburden in the North Extension area, is represented by 5 samples. Analyses of these samples indicate that the plant-extractable trace-element centent is about the same as in other rocks in the overburden, except that the lead and nickel content is generally lower. The lead content ranges from 0.60 to 0.84 ppm; nickel ranges from 0.06 to 0.74 ppm. The SAR of samples from the clinker ranges between 2.9 and 9.3.

Two splits (duplicates) of overburden samples from the East Decker area that had been analyzed by Northern Testing Laboratories were obtained from the Decker Coal Co. and analyzed by the U.S. Geological Survey[1/] to determine total elemental composition (table B-2, Appendix B). The total amounts of 9 elements in these samples were compared with the reported plant-extractable amounts of these same elements (table B-3, Appendix B). This comparison indicates that only a small fraction of the total amount of each element tested is plant-extractable, in some cases less than one percent.

[1/] Analyses were made by laboratories of the Geologic Division, Denver, Co.

Table 8.-- Summary of plant-extractable amounts of potentially toxic elements in samples of overburden from the Decker area

	East Decker area Plant-extractable amount (range in ppm)	North Extension area Plant-extractable amount (range in ppm)
Boron (B)	.03-1.2	[1] 0.01-2.97
Selenium (Se)	<.02-.12	[2] .01-.55
Molybdenum (Mo)	<.10-1.3	.18-3.93
Mercury (Hg)	[3] <.001-.024	[2] .001-.192
Cadmium (Cd)	[3] <.1-.4	.10-.25
Lead (Pb)	[4] <.1-4.2	.60-5.50
Nickel (Ni)	<.1-5.6	.06-8.20

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[1] Generally less than 0.5 ppm.
[2] Generally less than 0.1 ppm.
[3] Generally undetectable
[4] Generally less than 1 ppm.

Alluvial deposits of unconsolidated silt, sand, and gravel are found in the bottoms of all the larger stream valleys in the Decker area. These deposits have a maximum thickness of about 100 feet in Tongue River valley, about 40 feet in Deer Creek valley, and less than 40 feet in other stream valleys in the area. In addition, a few terrace deposits (ancient deposits of the Tongue River consisting of sand, pebbles, and cobbles) underlie the surface of several terrace remnants that lie adjacent to the Tongue River and 40 to 220 feet above the present river bed. These deposits are small and are not shown on the geologic map.

Rock strata composing the Tongue River Member in the Decker area are locally warped into several small flexures or folds of very low amplitude. For the most part, however, beds appear to be essentially flatlying with a regional southeastward dip of less than 1°. Several northeast-trending normal faults have been mapped in this area (fig. 32). One forms the southeast limit of mining in the West Decker area; another forms the southeast margin of the proposed East Decker mine. Strata have been dropped down as much as 200 feet on the southeast side of both faults.

b. Earthquake hazards

National Oceanographic and Atmospheric Administration (NOAA) Environmental Data Service records show that an earthquake having an intensity of V on the modified Mercalli scale[1/] occurred near Big Horn, Wyo., in November

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[1/] Use of the modified Mercalli scale for rating earthquakes predates the development and use of the modern Richter scale, which provides a measure of the release of energy during an earthquake. The modified Mercalli scale rates an earthquake on a scale of I to XII, depending on the effects reported by humans. An earthquake of intensity V would (1) generally be felt by local residents, (2) awaken most sleepers, and (3) cause bells to ring.

1925. The epicenter of this earthquake, which is the largest on record in this general area, was about 20 miles south of the Decker area. No damage would be expected in the Decker area from a tremor of this magnitude. A seismic risk map prepared by NOAA indicates that only minor damage should be expected from future earthquakes in this general area (Coffman and von Hake, 1970, p. 1).

No surface displacements that would indicate recent movement occur along any of the faults mapped in the Decker area. Moreover, an undisturbed, high terrace gravel locally covering the trace of one fault indicates no movement along this fault for many thousands of years. Thus, it is unlikely that mining activity in this area would trigger an earthquake or that an earthquake would cause landslides or slumping of spoils material into the Tongue River Reservoir.

c. Mineral Resources

(1) Coal

(a) Quality of the coal

According to standards established by the American Society for Testing Materials (1974), the coal to be mined in the Decker area is subbituminous B in rank. The coal has a low sulfur content of 0.2 to 0.9 percent, a low ash content of 3 to 7 percent, and a heating value of 9,000 to 9,900 Btu per pound (tables B-4 and B-5, Appendix B).

Coal samples analyzed for trace elements (table B-5, Appendix B), show that concentrations are generally much less than the national average for trace elements in coal (Swenson, et al., 1976). Burning this coal in electric-generation plants in Illinois, Michigan, and Texas as proposed, therefore, should not violate any applicable EPA standards regarding trace-element concentrations in plant emissions or waste products and should not pose a local trace-element related health problem.

(b) Quantity of coal

The area outlined on the geologic map (fig. 32) covers about 54 square miles. Excluding coal underlying the Tongue River Reservoir, which at spillway level (3,424 feet) submerges about 4 square miles, the coal in the Coal Reserve Base[1/] in this 50-square-mile area is estimated to be about 5.7 billion tons. About 11 percent of the identified coal resources or about 630 million tons lie within 200 feet of the surface and may be suitable for recovery by surface-mining methods. The Decker Coal Co. expects to recover about 106 million tons of coal.

(2) Oil and gas

There are no known resources of oil or gas in the Decker area. Nearest production is from the Ash Creek Field about 8 miles to the west on the Montana-Wyoming line (fig. 23) where about 5 million barrels of oil have been obtained from the Cody Shale of Cretaceous age.

Five oil and gas test holes have been drilled in the Decker area (fig. 32) to depths ranging from 3,840 to 8,850 feet. The shallowest of these holes tested the uppermost Cretaceous rocks; the other four tested the Cody Shale and adjacent Cretaceous formations. All holes were dry. Undiscovered resources of oil and gas may underlie the Decker area at greater depths or in untested parts of the area, but the lack of success to date does not make this an attractive area for exploration.

(3) Other minerals

Clinker underlies large areas in the Decker area to depths of as much as 135 feet. Clinker, because of its durability and ease of extraction

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[1/] See glossary for definition of Coal Reserve Base.

owing to fracturing, is used extensively for road surfacing material and for railroad ballast. The amount of clinker in this area is unknown, but probably exceeds 500 million cubic yards. Several small pits have been excavated locally for use on roads in the Decker area.

Surface or near-surface deposits of sand and gravel suitable for construction purposes are almost nonexistent in this area. The gravel capping on terrace remnants should be suitable for crushing, but these deposits are generally thin and of small areal extent. Several terrace deposits occur in the East Decker area in secs. 12 and 13, T. 9 S., R. 40 E., but none occurs in the North Extension area.

7. Soils

a. The soil resource

Most soils in the Decker area support a natural diverse plant cover that traditionally has been harvested by livestock and wildlife in keeping with the local ranching economy. Some small acreages have been subjected to dryland farming in past years with generally unsatisfactory results. Hay production has been possible locally in those areas where run-in moisture is spread by a system of dikes and ditches or where subirrigation occurs in the bottoms of those stream valleys that have shallow water tables. Excellent results have been obtained by these methods in the middle and upper reaches of Deer Creek valley in the East Decker area. Conversely, water spreaders in the lower reach of Pearson Creek valley in the North Extension area have not been maintained and are now largely defunct.

Irrigated hay fields on deep alluvial soils in the broad lower reach of Spring Creek valley in the North Extension area are highly productive.

Water is currently being pumped from the Tongue River Reservoir to irrigate about 437 acres. Crops, which include small grains and alfalfa hay grown in a rotation system, are used as supplemental feed for livestock.

b. Soil types

A soil survey of the Decker area has been completed by the Soil Conservation Service (SCS) as part of a larger effort to prepare a soils map of Big Horn County, Montana. Results of that survey, however, emphasize the suitability of the various soil types for agricultural purposes, rather than their general suitability for mine-land reclamation. Accordingly, the Decker Coal Co. contracted with R. L. Moshier, a retired soil scientist formerly with the Soil Conservation Service, to complete a specialized soil survey that would better suit reclamation objectives.

Moshier's survey, which was submitted by the Decker Coal Co. as part of their application for a surface-mining permit for the proposed East Decker and North Extension mines, emphasizes (1) the different soil types that would be disturbed by the proposed mining operations, (2) the areal extent of each soil type, (3) the average thickness of each soil type that could be salvaged for use as topsoiling materials, and (4) physical and chemical properties of soil types relevant to mine-land reclamation. The survey was made in accordance with standards prescribed by the Montana Department of State Lands using methods and procedures established by the U.S. Department of Agriculture.

A total of 29 soil series (table 9) were mapped in the Decker area. These series in turn were subdivided into 40 mapped units or soil types

Table 9.--Soil series mapped in the Decker area.

Series	Subgroup and family
Anko	Haplustollic Natrargids-fine-loamy, mixed Mesic
Colbar	Ustic Torriorthents-fine-silty, mixed (calcareous), Mesic
Corkim	Ustollic Camborthids-coarse-loamy, mixed, Mesic
Haverson*	Ustic Torrifluvents-fine-loamy, mixed, (calcareous), Mesic
Heldon	Ustollic Camborthids-clayey over loamy, montmorillonitic, Mesic
Hysham*	Ustic Torriorthents-fine-silty, mixed, Mesic
Keiser*	Ustollic Haplargids-fine-silty, mixed, Mesic
Kim*	Ustic Torriorthents-fine-loamy, mixed (calcareous), Mesic
McRae*	Ustollic Camborthids-fine-loamy, mixed, Mesic
Midway*	Ustic Torriorthents-clayey, montmorillonitic, (calcareous) Mesic, shallow
Nelar	Ustic Torriorthents-coarse-loamy, mixed (calcareous), Mesic
Nelson*	Ustic Torriorthents-coarse-loamy, mixed (calcareous), Mesic
Nevee*	Ustic Torriorthents-coarse-silty, mixed (calcareous), Mesic
Neville*	Ustic Torriorthents-fine-loamy, mixed (calcareous), Mesic
Okar	Haplustollic Natrargid-fine, montmorillonitic, Mesic
Olney*	Ustollic Haplargids-fine-loamy, mixed, Mesic
Redby	Ustic Torriorthents-loamy, mixed (calcareous), Mesic
Shingle*	Ustic Torriorthents-loamy, mixed (calcareous), Mesic shallow
Sperlin	Ustic Torriorthents-coarse-loamy, mixed (calcareous), Mesic
Stoneham*	Ustollic Haplargids-fine-loamy, mixed, Mesic
Tassel*	Ustic Torriorthents-loamy, mixed, (calcareous), Mesic, shallow
Tensleep**	Ustollic Haplargids-fine-silty, mixed, Mesic
Terry*	Ustollic Haplargids-coarse-loamy, mixed, Mesic
Travessilla*	Lithic Ustic Torriorthents-loamy, mixed (calcareous), Mesic
Tullock*	Ustic Torripsamments-mixed, Mesic
Valent*	Ustic Torripsamments-mixed, Mesic
Wanetta*	Ustollic Haplargids-fine-loamy over sandy or sandy skeletal mixed, Mesic
Wibaux*	Lithic Ustic Torriorthents-loamy, mixed (calcareous), Mesic
Yenlo	Haplustollic Natrargids-fine-loamy, mixed, Mesic

* Established Series

** Tentative Series

All others are names used in this legend for identification purposes.

(table 10; figs. 36 and 37). Individual mapped units may consist of a combination of soil series, a single soil series, or a distinctive complex within a soil series. Units mapped in the Decker area, therefore, include soil complexes such as the Shingle-Wibaux complex; soil associations such as the Sperlin-Wibaux rocky loams; and undifferentiated groups such as terrace escarpments, loamy. Unlike conventional soil surveys, which generally emphasize slope phases of soil series because of the importance of slope to agriculture, comparatively little emphasis was placed on slope in Moshier's mapping. Differences in slope within a soil series generally do not affect the character and suitability of the soil materials for use in mine-land reclamation. Slope phases of the same soil series were mapped, therefore, only where it was necessary to show significant differences in depth to bedrock, soil salinity, or soil composition. Slope was not included in the nomenclature of the mapped units. Topographic relief and range of slope, however, are included in the description of the various mapped units (Appendix B).

In conjunction with mapping, the modal profile of each soil type was determined by augering holes at appropriate locations. At least two soil profiles within each mapped unit or soil type were sampled at appropriate depth intervals. All soil profiles were sampled to a minimum depth of 60 inches unless bedrock was penetrated at less depth. Many soil profiles were sampled to a depth of 12 feet. The samples thus obtained were analyzed to determine pH, specific conductance, saturation percentage, texture, calcium, magnesium, sodium, and boron. The sodium adsorption ratio 1/ (SAR) was calculated from the relative amounts of

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1/ See Glossary for definition and method of calculation of sodium adsorption ratio.

Table 10.--Soil phases mapped in the Decker area.

Symbol on Map	Name of mapping unit	Symbol on Map	Name of mapping unit
1	Tensleep silt loam	18E	Tassel Shingle loams
2	Alluvial lands, loamy	19	Shingle-Travessilla complex
3	Nelar loam	19E	Shingle-Travessilla complex
4	Corkim loam	20	Shale outcrop
4c	Corkim loam	21	McRae loam
5	Sperlin-Wibaux	22	Valent-Tullock loamy sands
6	Kim loam	23	Wanetta loam
7	Keiser silty clay loam	24	Stoneham loam
8	Wibaux-Sperlin complex	25	Sperline-Wabaux rocky loams
9	Shingle-Wibaux complex	26	Nelson-Tassel sandy loams
10	Neville loam	27	Shingle-Midway - shale outcrop complex
11A	Colbar silt loam	28	Tassel-Corkim loams
11C	Colbar silt loam	29	Shingle-Wabaux - rock outcrop complex
12	Haverson loam	30	Olney fine sandy loam
13	Yenlo-Anko complex	31	Keiser-Okar silty clay loams
14	Redby silt loam	32	Alluvial lands, loamy saline
15	Yenlo-Anko complex, bedrock substratum	33	Nelson-Tassel rocky sandy loams
16	Nevee silt loam	34	Heldon silty clay
17	Shingle-Midway loams	38	Terry-Tassel sandy loams
17E	Shingle-Midway loams	40	Terrace escarpments, loamy
18	Tassel-Shingle loams		

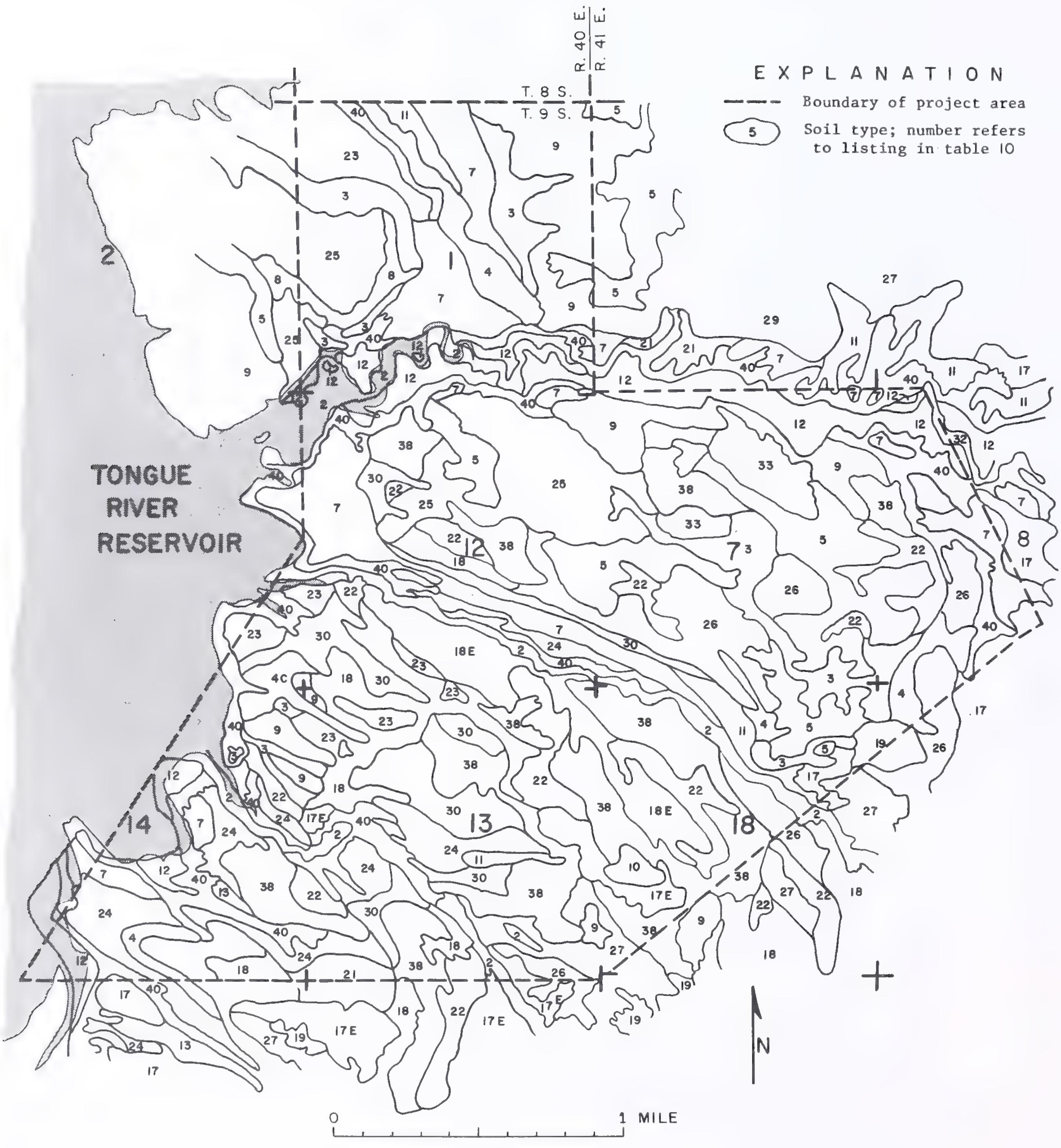


Figure 36. — Map showing soil types in the East Decker area.

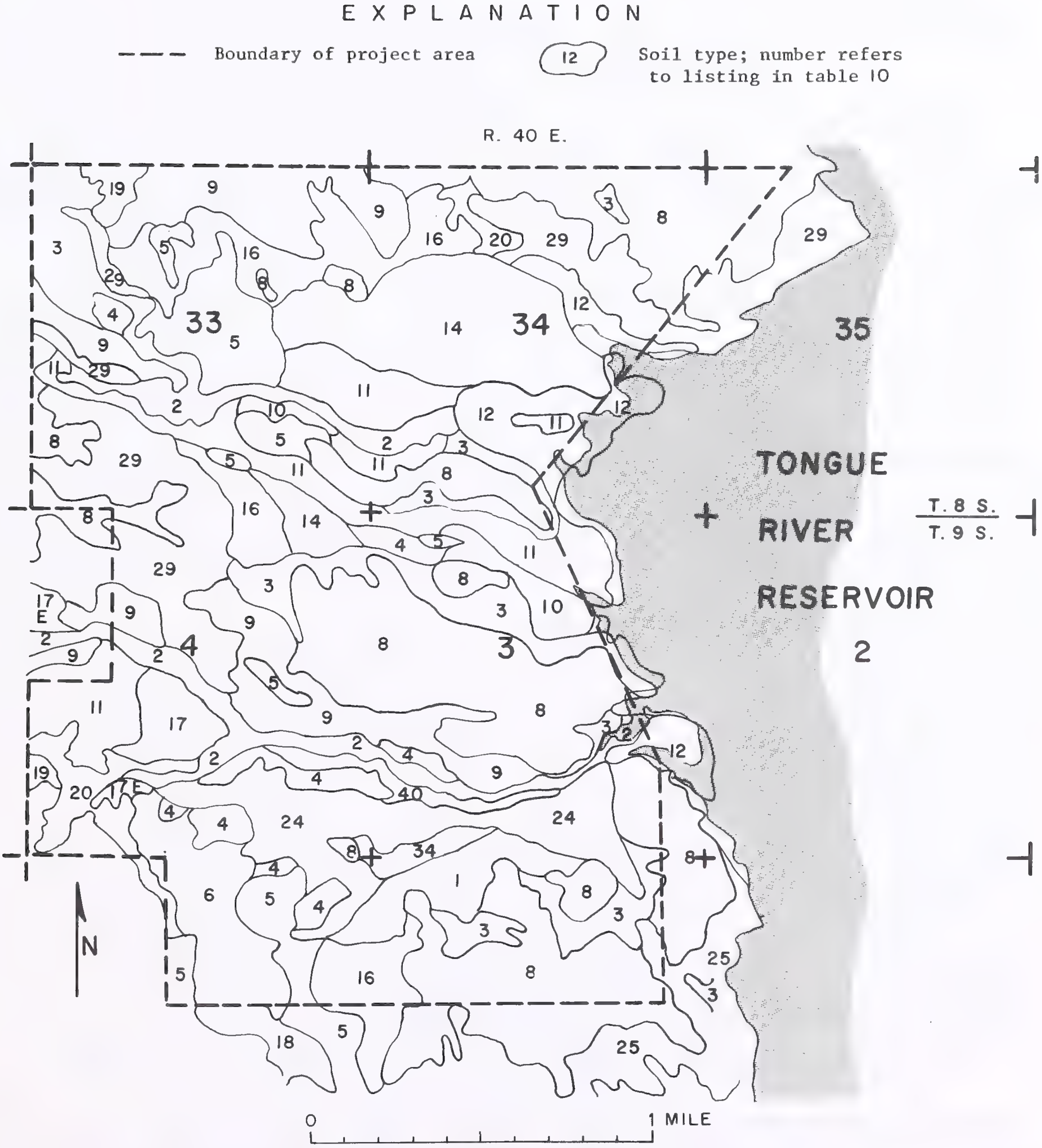


Figure 37.- Map showing soil types in the North Extension area.

calcium, magnesium, and sodium in the respective samples. Results of these analyses, coupled with observed physical characteristics of the various soil types, formed the basis for appraising the suitability of existing soils for use as topsoiling materials (table 11).

c. Soil characteristics and relationships

Soils in the Decker area are formed in residuum, alluvium, or a combination of these materials, most of which have been derived from the Tongue River Member of the Fort Union Formation. Some alluvial soils, especially those in the larger stream valleys, are derived in part from the Wasatch Formation.

Residual soils generally occur on upland areas such as hillslopes and ridges that are source areas of sediment. As a rule, they closely reflect the character of the underlying parent materials in color, texture, mineral composition, and salinity. For example, light-colored sandstone generally weathers to form light-colored, nonsaline to moderately saline sandy loams that are commonly nonsodic. In contrast, siltstone and shale generally weather to form silty, clay soils of comparable color that commonly are moderately to highly saline and contain sodium as the dominant cation. In areas where the parent rocks have been altered to clinker by the heat from naturally burning coal beds (p. 125), soils are characteristically red or reddish brown, contain clinker fragments in the C horizon, and generally are less saline than most other soils in the area.

Alluvial soils are best developed in the broad valley bottoms and adjacent slopes where sediment derived from erosion of the upland has accumulated to form flood plains, terrace deposits, alluvial fans, and

Table 11. --Estimated depths of soil materials and their suitability for use as topsoil in mine-land reclamation.

Series	Symbol on map	Total soil depth	Qualitative rating and thickness of materials suitable for use as topsoil
Anko	13	6 to 12+ feet	Fair; lower part of soil profile may be poor to unsuitable because of high SAR and slight to moderate salinity
	15	30 to 48 inches	
Colbar	11	8 to 12+ feet	Good to 8 feet; good to poor below that depth, depending on SAR and salinity
	11B	5 to 10+ feet	Good to 4 feet; good to poor below that depth, depending on SAR and salinity
Corkim	4	8 to 12+ feet	Good to at least 8 feet
	4C	4 to 8+ feet	Good to at least 6 feet; materials below that depth may have SAR or salinity problems at some sites
Haverson	12	4 to 8+ feet to gravel or unconsolidated sand	Good to unconsolidated sand or gravel
Heldon	34	8 to 12+ feet	Good to at least 8 feet; materials below that depth may have a SAR or salinity problem
Hysham	6	4 to 10+ feet	Poor to unsuitable because of moderate to high SAR and salinity
Keiser	7	6 to 10+ feet	Good to at least 6 feet
	31		Good to poor, depending on SAR and salinity
Kim	6	4 to 12+ feet	Good to poor, depending on local SAR and salinity
McRae	21	6+ feet	Good to 6 feet; good to poor below that depth, depending on SAR and salinity
Midway	17	10 to 20 inches	Good to fair, but may be too variable in depth within short distances to be salvaged satisfactorily
	17E	6 to 12 inches	
	27	Less than 8 inches	
Nelar	3	5 to 10+ feet	Good
Nelson	26	20 to 40 inches	Good to 40 inches; good or fair in the underlying poorly consolidated sandstone
	33		
Nevee	16		Good
Neville	10	6 to 12+ feet	Good to at least 8 feet; materials below this depth may have SAR or salinity problem

Table 11. --Estimated depths of soil materials and their suitability for use as topsoil in mine-land reclamation (continued).

Series	Symbol on map	Total soil depth	Qualitative rating and thickness of materials suitable for use as topsoil
Okar	31	3.5 to 10+ feet	Good to fair in upper 18 to 24 inches; fair to unsuitable below 24 inches because of SAR and salinity
Olney	30	6 to 12+ feet	Good to at least 12 feet
Redby	14	8 to 12+ feet	Good to at least 8 feet; materials below this depth may have a SAR or salinity problem
Shingle	9	Less than 10 inches	Good to fair but may be too variable within short distances to be salvaged satisfactorily; the siltstone underlying may disintegrate sufficiently as a result of excavation and subsequent weathering to be suitable for use as topsoil or near surface materials
	17	10 to 20 inches	
	17E	Less than 10 inches	
	18	10 to 20 inches	
	18E	Less than 10 inches	
	27	Less than 6 inches	
	29	Less than 6 inches	
	19	10 to 20 inches	
	19E	Less than 10 inches	
Sperlin	5	20 to 40 inches	Good
	8		
	22		
Stoneham	24	8 to 12+ feet	Good to 8+ feet; materials below this depth may have a SAR or salinity problem at some sites
Tassel	18	10 to 20 inches	Good on soil mantle; good to fair in the underlying poorly consolidated sandstone
	18E	Less than 12 inches	
	26	10 to 20 inches	
	28		
	33		
Tensleep	1	8 to 12+ feet	Good to 8+ feet; materials below this depth may have a SAR or salinity problem
Terry	28	20 to 40 inches	Good on soil mantle; good to fair in the underlying poorly consolidated sandstone
Travesilla	19	8 to 20 inches	Unsuitable for use as topsoil because of high content of coarse fragments and shallow depth to hard sandstone
	19E	Less than 8 inches	
Tullock	22	20 to 40 inches	Fair; loamy sand texture has low available water capacity and high wind-erosion hazard
Valent	5	4 to 8 feet	
	22		

Table 11. --Estimated depths of soil materials and their suitability for use as topsoil in mine-land reclamation (continued).

Series	Symbol on map	Total soil depth	Qualitative rating and thickness of materials suitable for use as topsoil
Wibaux	5	6 to 20 inches	Unsuited; too variable in depth; has high content of rock fragments within short distances
	8		
	22		
	29	Less than 6 inches	
Yenlo	13	6 to 12+ feet	Fair to good to 30 inches; poor or unsuitable below that depth because of SAR
	15	30 to 48 inches	

Miscellaneous Soil Types Related to Land Forms

Alluvial lands loamy	2	4 to 10+ feet to gravel, sand or bedrock	Variable, but primarily of good quality
Alluvial lands loamy, saline	32	4 to 10+ feet to gravel, sand or bedrock	Unsuitable; too wet and too saline
Shale outcrop	20	Less than 4 inches	Unsuitable; little or no soil mantle
Terrace escarpment loamy	40	5 to 12+ feet	Variable, but usually about same quality as those soils with which it is associated; however, SAR or salinity problems may occur locally

alluvial slopes. These soils commonly are composed of a heterogeneous mixture that reflects both the variety of the source areas and the depositional environment. Textures range from sandy loam to silty clay. Color ranges widely depending primarily on parent materials and organic content.

Because of the natural sorting and leaching that occurs during the transport and deposition of alluvial materials, the soils formed on alluvial deposits generally are more permeable and less saline than residual soils. An exception, however, occurs in those areas where sediments derived from siltstone and shale beds exposed in erosional escarpments are deposited down slope a short distance away on the broad alluvial-veneered surfaces that slope away from the base of these escarpments. Soils in these areas are characteristically fine grained, poorly sorted, relatively impermeable, and often moderately to highly saline if the parent materials contain appreciable amounts of soluble constituents.

d. The sodic-soils problem

Present operations at the West Decker mine have focused attention on the occurrence of sodic-soils in the Decker area and on the problems associated with accomplishing reclamation objectives using these soils. The sodium adsorption ratio (SAR) of a soil or a rock sample has been generally adopted as an effective indicator of the suitability of that material as a medium for plant growth. The SAR of a sample is in fact a useful criterion, but it alone is not necessarily indicative of a sodic-soils problem. Other equally important factors are soil salinity (total soluble constituents in the soil) and soil texture.

The sodic-soils problem stems largely from cation exchange on the surfaces of expanding-lattice clay minerals of the montmorillonite group. Bentonite is an example of an expanding-lattice clay, i.e., this clay expands when it is wetted and water is drawn by molecular forces into the mineral lattice. Additional expansion occurs when water is drawn between adjacent clay-mineral particles and forces these particles apart. Conversely, the clay shrinks once again as it drys. If an expanding-lattice clay contains calcium or magnesium ions on the exchange surfaces, expansion may be several times the dry volume. If the clay contains sodium ions, significantly greater volumetric expansion will normally occur. Replacement of calcium or magnesium ions on the exchange surfaces of a clay mineral by sodium ions occurs readily whenever an excess of sodium ions are introduced into the system. Conversely, replacement of sodium by calcium or magnesium will occur just as readily in the presence of an excess of those ions. The reversible ion exchange phenomenon in swelling-clay soils, therefore, is much like the reversible ion exchange that occurs in a zeolite water softener.

Clays in bedrock formations in the Decker area and in soils derived from these rocks are typically of the expanding-lattice or swelling type. Because sodium salts are generally more soluble than those of calcium and magnesium, soils in the Decker area are often leached to the extent that they contain comparatively little sodium. The existing soils, therefore, generally contain low-swell clays in which calcium and magnesium ions occupy most exchange positions. An exception apparently occurs in those areas previously described where soil-veneered surfaces slope away from eroding shale or siltstone escarpments that provide a perennial source of fine-grained sediments and sodium salts. The soils in these areas commonly are fine textured, moderately saline and plastic, and have high SAR values.

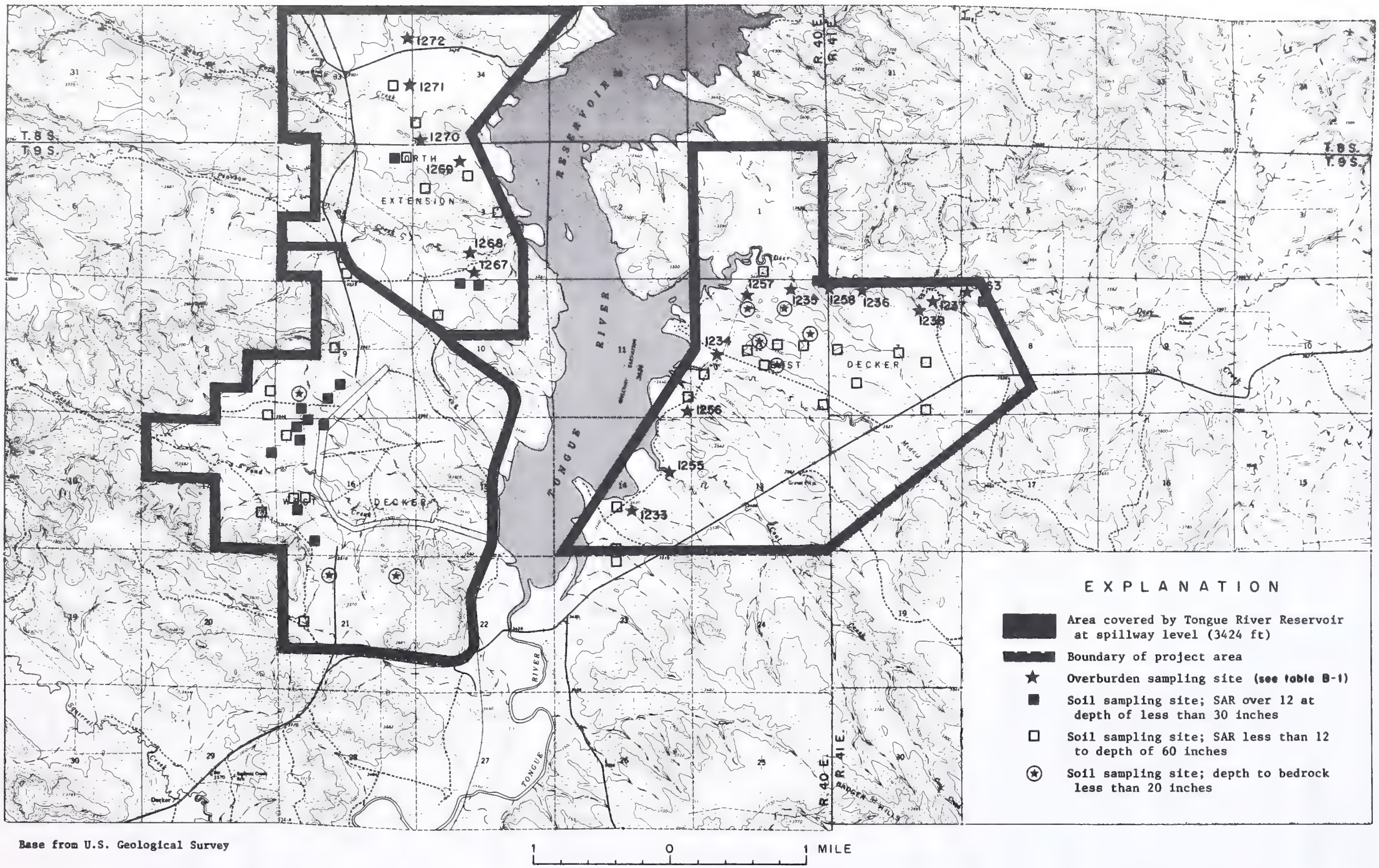
Despite their expansion on wetting, low-swelling clays in a soil profile do not seriously inhibit soil permeability and water intake. Obviously, however, the permeability of clay soils in the Decker area would be significantly reduced by the addition of sufficient amounts of sodium to the system to convert the clays from low-swell to high-swell characteristics. The result would be a pronounced change in soil characteristics, attributable in part to the expansion of the clay minerals and in part to accompanying dispersion of soil colloids by the sodium ions. Saline-sodic (alkali) soils tend to become hard and crusted when dry and highly plastic and sticky when wet. Greatest expansion and lowest soil permeability, however, typically occur under non-saline-sodic (alkali) conditions when SAR values are moderate to high and total salinity is low. Increased runoff, less infiltration and less soil moisture for plant growth, would follow. Similar results would be obtained by replacing the existing low-swell soils with an admixture containing appreciable amounts of sodic materials.

It follows from the foregoing discussion that the presence of sodium ions in or the addition of sodium ions to a fine-grained soil in the Decker area such as a clay loam would very probably result in reduced soil permeability, low water intake, and consequent increased runoff and erosion on this soil type. Conversely, a sandy loam containing relativey little clay would be minimally affected by the presence or addition of sodium ions. Moreover, the sodium adsorption ratio (SAR) is an index of the relative equivalence of sodium and calcium plus magnesium ions in a sample and not a measure of the actual amount of sodium present. Thus, SAR values alone may be very misleading. A sandy loam, for example, could have a SAR in excess of 100, and yet the adverse effect of sodium on the soil profile could be inconsequential. The apparent sodic-soils problem in the Decker area, therefore, must be appraised in relation to soil texture, total salinity, and exchangeable sodium as indicated by SAR values.

To assess the probable magnitude of the sodic-soils problem in the Decker area, soil and overburden sampling sites described by Moshier (Appendix B) were located and identified according to SAR values and soil depth (fig. 38). Of 18 soil profiles sampled in the West Decker area, 10 had SAR values sufficiently high to indicate a possible sodic-soils problem. Only 2 of 18 soil profiles in the East Decker area and 3 of 12 profiles in the North Extension area had SAR values that might indicate local sodic soils.

All 10 sample sites in the West Decker area having apparent sodic soils are on the broad depositional surface that slopes generally eastward away from the base of an irregular eroding escarpment toward the Tongue River Reservoir. The source of sodium in these soils apparently is the predominatly fine-grained sequence of shale, siltstone, and sandstone beds exposed in the nearby escarpment. Because the soils on this depositional surface are generally fine grained and at least moderately saline, a sodic-soils problem does exist in this part of the Decker area.

The same depositional surface extends northward into the North Extension area where it forms the southwest slope of Pearson Creek valley. The


EXPLANATION
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of project area
★ Overburden sampling site (see table B-1)
■ Soil sampling site; SAR over 12 at depth of less than 30 inches
□ Soil sampling site; SAR less than 12 to depth of 60 inches
⊛ Soil sampling site; depth to bedrock less than 20 inches
TONGUE RIVER RESERVOIR
DECKER
EXTENSION
T.8S.
T.9S.
R.40E.
R.41E.
1272
1271
1270
1269
1268
1267
1257
1235
1258
1236
1237
1238
1234
1256
1255
1233
1 0 1 MILE

Base from U.S. Geological Survey

Figure 38.- Map showing location of overburden and soil sampling sites in the Decker area.

escarpment at the head of the slope in this part of the area, however, is predominatly sandstone. Two soil profiles on the depositional surface in the south-central part of sec. 4, T. 9 S., R. 40 E. (fig. 38) were nonsodic. As no such escarpments and related depositional surfaces occur in the East Decker area, apparently no extensive or well-defined sodic-soils problem exists in either the East Decker or North Extension areas. The apparent sodic-soils in these areas, as indicated by SAR values above 12, are discussed in conjunction with the description of the soils in these areas.

e. Soils in the East Decker area

Soils in the East Decker area (fig. 36) tend to reflect existing land forms to the extent that residual soils generally occur on hilltops and erosional benches whereas alluvial soils underlie the valley bottoms and transitional valley side slopes. Soil phases represented by the various map units commonly grade imperceptibly from one into another over a distance of several tens of feet. Contacts as shown on figure 36, therefore, are approximate only.

Residual soils are characteristically thin, have poorly developed A and B horizons, and closely reflect the shallow underlying bedrock. In the area south of Middle Creek valley, residual soils are formed on sandstone and siltstone with minor amounts of shale. These soils are generally friable, nonsodic, range in texture from silty to sandy loam, and are less than 20 inches thick. North of Middle Creek valley in the northern half of the proposed mine area, the bedrock has been altered to clinker by the burning of the Anderson coal bed (fig. 32). Residual soils formed on the clinker are characteristically red to reddish brown in color, nonsodic, fine to medium textured, and also generally less than 20 inches thick.

Alluvial soils are comparatively deep, generally exceeding 4 feet to bedrock in the smaller valleys and exceeding 8 feet to bedrock in the larger valleys. Despite their appreciable depth, however, the A and B horizons of these alluvial soils generally are only 6 to 20 inches thick. Development of deep A and B horizons apparently is retarded in part by the semiarid climate, which limits the amount of soil moisture available for plant growth, and in part by the natural accumulation of sediments on the surface in aggrading areas underlain by alluvial soils. The repeated burial of the A horizon by accumulating sediments tends to restrict the buildup of carbonaceous materials in a stable A horizon and deters normal processes of soil development. Soil textures range from sandy loam to clay loam, depending on source areas, but most alluvial soils in the East Decker area are friable, nonsodic and are classed as loam or silt loam.

The comparatively thin A and B horizons on both residual and alluvial soils in the East Decker area would not be adequate for postmining reclamation. Emphasis, therefore, is necessarily placed on (1) the suitability of materials in the C horizon of alluvial soils for use as a topsoil and (2) the suitability of the overburden for placement near the surface.

Soil profiles in the East Decker area (fig. 37 and Appendix B) show the C horizon of the alluvial soils to be largely medium textured. Three samples representing map units, 9, 33, and 38 showed SAR values above 12 for the C horizon. All three samples were medium to coarse textured and had low to moderate salinity. The SAR values obtained, therefore, are not considered to be indicative of a sodic-soils problem in the East Decker area. It should be noted, however, that no representative soil samples were collected in the southeastern part of the proposed mine area (fig. 38). Although unlikely because of the predominance of siltstone and sandstone in this part of the area, further sampling might reveal a local sodic-soils problem. Figure 39 shows the estimated thickness of soil materials in the East Decker area that probably would be suitable for use as topsoil.

Overburden analyses (Appendix B) show these rocks to be generally medium to coarse textured. They are typically low in salinity and SAR values from the surface downward to the first coal bed. Below the uppermost coal bed, however, they are generally high in both salinity and SAR values and would not be suitable for placement near the surface.

f. Soils in the North Extension area

As in the East Decker area, soils in the North Extension area tend to closely reflect the existing land forms. Residual soils generally occur on the rolling terrain that forms the interstream uplands whereas alluvial soils underlie the broad valley bottoms and the transitional valley side slopes. Mapped soil phases (fig. 37) generally grade from one into another over a distance of several tens of feet. Contacts shown on figure 37, therefore, are approximate only.

Residual soils are generally thin, have poorly developed A and B horizons, and closely reflect the shallow underlying bedrock, virtually all of which is clinker (fig. 32). The clinker varies widely in character from one locality to another, depending on the parent materials and the extent of alteration caused by the heat generated by burning of the Anderson coal bed. Residual soils mirror these differences and vary widely in texture, salinity, and SAR values. Most residual soils, however, are medium textured

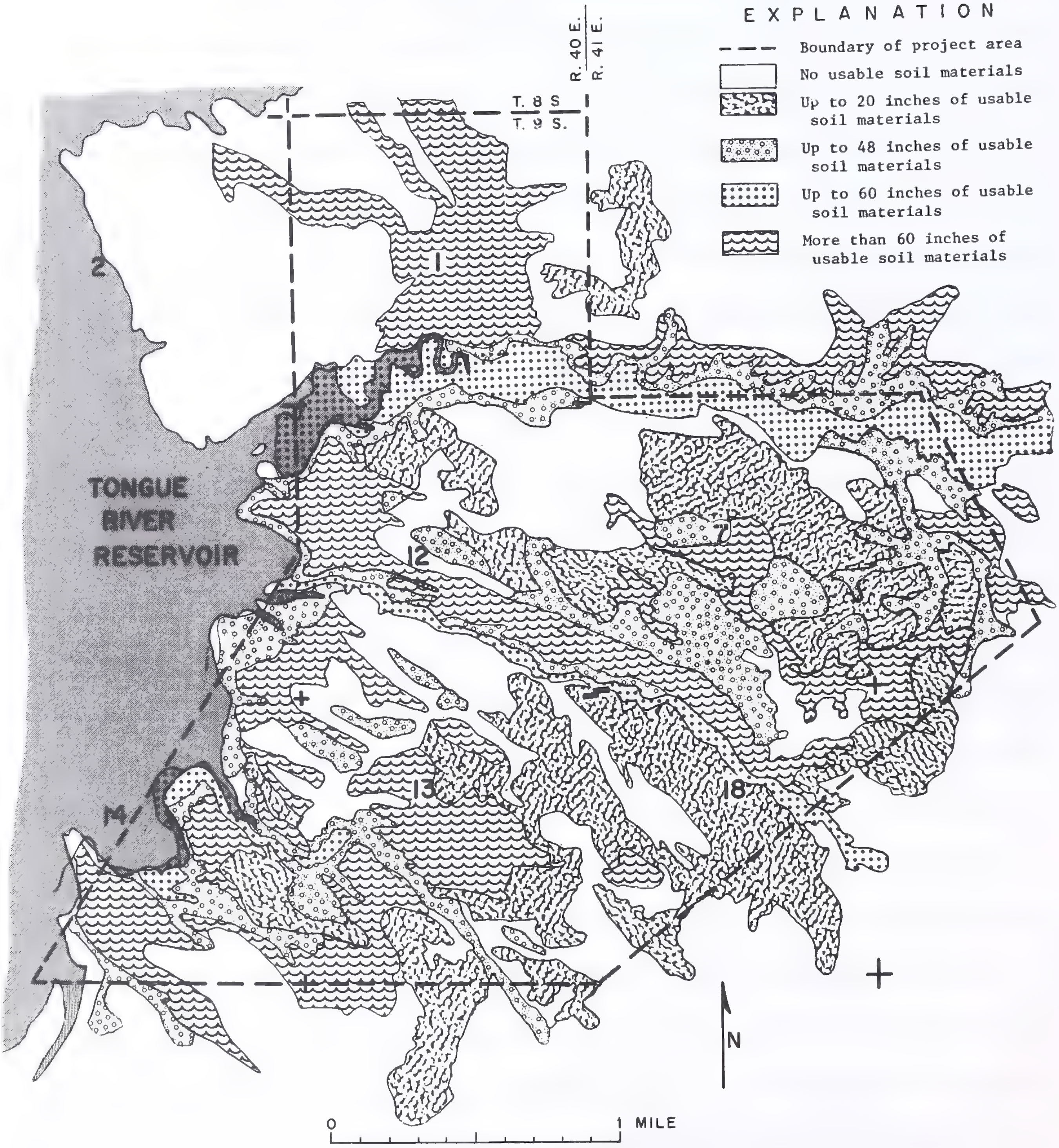

EXPLANATION
Boundary of project area
No usable soil materials
Up to 20 inches of usable soil materials
Up to 48 inches of usable soil materials
Up to 60 inches of usable soil materials
More than 60 inches of usable soil materials
R. 40 E.
R. 41 E.
T. 8 S.
T. 9 S.
TONGUE RIVER RESERVOIR
2
1
7
12
13
14
18
N
0
1 MILE

Figure 39.— Map showing estimated thickness of soil materials in the East Decker area that could be used as topsoil.

and nonsodic to only moderately sodic. Their greatest deficiency lies in their shallow depth. Map units 9, 17, 17E, 19, 20 and 29 (fig. 37) are examples of shallow soils, generally less than 12 inches deep, that may not be salvable for use in mine-land reclamation.

Alluvial soils are comparatively deep, generally exceeding 4 feet to bedrock on the valley side slopes and exceeding 12 feet to bedrock in the bottoms of Spring and Pearson Creek valleys. As in the East Decker area, the combined thickness of the A and B horizons generally does not greatly exceed 20 inches because of the climate and the depositional environment. Soil textures range from sandy loam to clay loam, depending on source areas. The finer textures typically occur on the flood plains and valley side slopes whereas the coarser textures occur along the water courses in the valley bottoms. Most of these soils are friable, nonsodic, and classed as sandy loam, loam, or silt loam. The exceptions may be the Tensleep silt loam, the Kim loam, and the Nevee silt loam (map units 1, 6, and 16, fig. 37). Sampling results indicate that these soil phases may be too sodic for use as topsoil.

As in the East Decker area, postmining reclamation in the North Extension area would require the use of materials in the C horizon of alluvial soils because of the comparatively thin A and B horizons on both residual and alluvial soils. As indicated above, these materials generally should be suitable for use as topsoil, with the possible exception of soil phases 1, 6, and 16 (table 11 and fig. 37). Although unlikely because of the dominance of clinker, further sampling in the northern and western parts of the proposed mine area might reveal a local sodic-soils problem. Figure 40 shows the estimated thickness of soil materials in the North Extension area that probably would be suitable for use as topsoil.

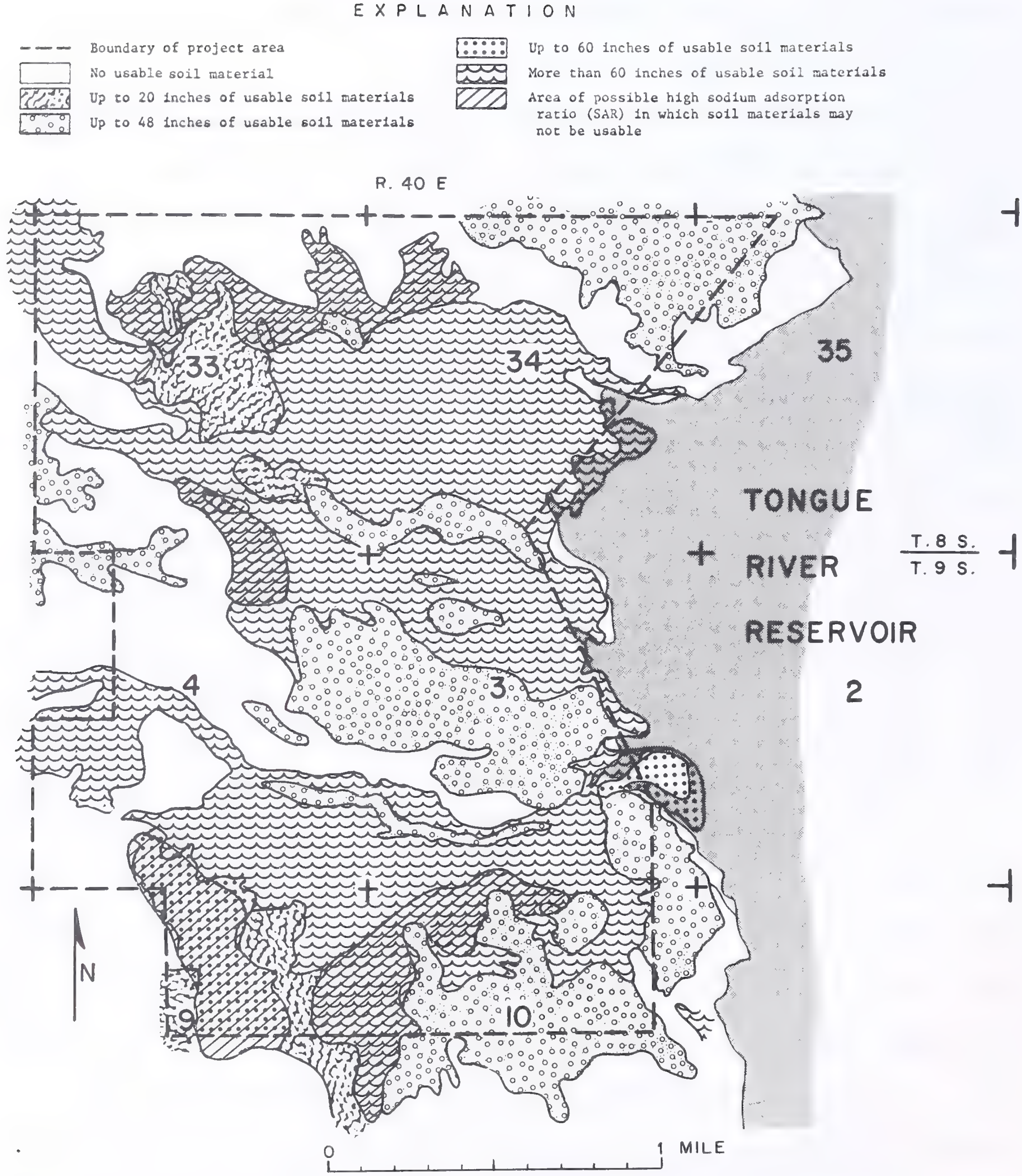

EXPLANATION
Boundary of project area
No usable soil material
Up to 20 inches of usable soil materials
Up to 48 inches of usable soil materials
Up to 60 inches of usable soil materials
More than 60 inches of usable soil materials
Area of possible high sodium adsorption ratio (SAR) in which soil materials may not be usable
R. 40 E
33
34
35
TONGUE RIVER RESERVOIR
T. 8 S.
T. 9 S.
4
3
2
N
9
10
0
1 MILE

Figure 40.- Map showing estimated thickness of soil materials in the North Extension area that could be used as topsoil.

Overburden analyses (Appendix B) show these rocks to be generally medium textured and low in both salinity and SAR values to the first coal bed or to the base of the clinker where the coal has burned. The overburden is often moderately saline and sodic below the first coal. The single exception was the northernmost sampling site (drill hole 1267) in the NE¼, sec. 33, T. 8 S., R. 40 E. (fig. 38). Analyses of samples from this hole showed a predominance of sodic silt and clay loams to a depth of 177 feet. The limited data available, therefore, would indicate that most of the clinker overburden in the North Extension area is suitable for placement near the surface. Conversely, the underlying materials would not be suitable for shallow burial.

8. Hydrology

a. Ground water

Information relative to ground water in the Decker area has been derived from several sources. The earliest published accounts are contained in two reports of the U S. Geological Survey (Baker, 1929; and Thom and others, 1935). Results of recent studies are published in reports by Hopkins (1973), Van Voast (1974), the Ground-Water Subgroup (1974), and Van Voast and Hedges (1975). Reports on nearby areas that contain relevant information are Lowry and Cummings (1966), Taylor (1968) and King (1974).

Much pertinent ground-water data were obtained from two ongoing investigations in the area. In 1970, the Montana Bureau of Mines and Geology began a study in the Decker area to determine premining hydrologic conditions, to establish a ground-water observation program, and to monitor and understand mining-related hydrologic changes. Results of these studies are reported by Van Voast (1974) and Van Voast and Hedges (1975). In 1973, the U.S. Geological Survey initiated a study to provide additional base-line information on the hydrology of the Decker and surrounding areas. Data from these studies have been relied on heavily for this analysis of the impact of the proposed mining plan on shallow ground-water supplies.

(1) Sources of ground water

The principal sources of ground water that have been developed in the Decker area include the aquifers formed by beds of coal and associated lenses of sandstone in the Tongue River Member and by saturated zones at the base of the clinker and alluvium. The aquifers formed by the coal beds in the Tongue River Member are the most predictable sources of ground water owing to their continuity over broad areas. Although coal does not have appreciable primary porosity or permeability, beds of coal in their natural state are rendered more permeable by fractures that provide minute openings for the storage and transmission of ground water. In most locations the coal beds are sufficiently permeable to yield adequate amounts of water for domestic and stock use. Yields up to 60 gal/min have been obtained in the Decker area, but yields generally do not exceed 10 gal/min.

Water generally occurs in the coal beds under artesian pressure, that is, static water levels in wells finished in a coal bed will stand above the level at which the top of the coal was penetrated by the wells. In some areas, such as the low-lying flood plains around the Tongue River Reservoir, artesian pressures in the coal beds are sufficient to raise water levels above the land surface, thereby causing wells to flow. Three flowing wells have been drilled in the Decker area (table D-1, Appendix D). One of these wells (no. 43) was finished in 1974 in the Canyon coal bed in the NE¼ sec. 3, T. 9. S., R. 40 E. It began flowing at the rate of about 10 gal/min, and about 14 months later, the flow had decreased to less than 1 gal/min.

This decrease in flow reflects the lowering of artesian head as water is removed from the aquifer. In time this well may cease to flow, indicating that the artesian head in the aquifer has been lowered to a level below the point of outflow from the well. This is common in areas where the outflow or removal of water from an artesian aquifer exceeds the capacity of the aquifer to transmit water or the rate of replenishment to the aquifer.

Sandstone aquifers in the Tongue River Member occur as permeable discontinuous lenses in the otherwise less-permeable material that forms the the overburden and interburden above and between the coal beds. They appear to be isolated bodies with very limited degrees of hydraulic interconnection. Withdrawal of ground water from one of these aquifers would probably have little immediate effect on one nearby.

The recorded yields of wells finished in the sandstone aquifers in the Decker area range from 4 to 36 gal/min (Van Voast and Hedges, 1975, table 2). Although these values represent the rate at which ground water can be withdrawn from the sandstone aquifers, they do not necessarily reflect long-term dependable yields. Very probably, continuous pumping at maximum rates would exceed the rates at which ground water can be replenished in these aquifers. Such overpumping could eventually deplete the limited volume of ground water in storage in these aquifers, thereby causing wells to fail.

Clinker ranks among the most permeable aquifer materials in the Decker area. It contains two kinds of rock openings. The baked rock is extremely fractured while the fused rock is prone to contain tubular or pipe-like openings (see discussion in geology, p. 125). These two types of openings are intermixed to the extent that in any given area the entire rock mass has a very high porosity and permeability. Water from precipitation or from surface runoff enters the clinker and accumulates to form a zone of saturation in the lower part of the porous material. Where the base of the clinker is exposed at the land surface, springs are likely to occur. Where the clinker underlies low areas, however, the top of the zone of saturation rises until it reaches a spill-over level. Clinker materials adjacent to the Tongue River Reservoir (fig. 32) tend to be recharged by inflow from the reservoir during high stage and subsequently discharge to the reservoir during low stage.

The high permeability of the clinker can be inferred from the rate of outflow from these rocks adjacent to the Tongue River Reservoir when the level of the reservoir is rapidly lowered and water in storage in the clinker drains back into the reservoir. In September 1975, after the reservoir was lowered to permit needed repairs on the outlet structure, discharge from clinker in a reach about a thousand feet long in the NE¼ sec. 11, T. 9 S., R. 40 E., was estimated to be not less than 5 cubic feet per second (ft^3/s) and possibly as much as 10 ft^3/s. This outflow from the clinker included discharge from a spring estimated to flow about 2 ft^3/s (table D-5, Appendix D).

Water supplies obtained from alluvium in the Decker area are relatively few in number owing to the limited areal extent of saturated zones in these deposits. About 20 wells obtain water from alluvium along the margins of the Tongue River Reservoir and on flood plains of the Tongue River and the larger streams draining the adjacent upland area. No data are available on the yields of wells furnished in the alluvium in the

Decker area. Based on the character of the material, however, wells finished in the alluvium might yield as much as 10 gal/min for each 10 feet of saturated thickness.

Additional supplies of ground water probably could be developed from deeper aquifers. For example, Thom and others (1935, p. 195) report that an artesian flow was encountered at a depth of 1,300 feet in an oil test well in the NW¼ sec. 21, T. 9 S., R. 40 E.[1/] The probable occurrence of aquifers at still greater depths can be inferred from the water-bearing characterisitics of the rock units that occur in the subsurface (see table 7). The most noteworthy are the Hell Creek-Fox Hills aquifer (Ground-water Subgroup, 1974, p. 23) and the Madison Limestone (Swenson, 1974). The depths to these potential sources of ground water range from 3,500 feet for the Hell Creek-Fox Hills aquifer to about 9,000 feet for the Madison Limestone. Wells finished in either of these aquifers would probably flow profusely at the land surface owing to the high artesian heads under which ground water is believed to occur in these aquifers. Although the potential exists, there are no present (1975) plans for the development of ground-water supplies from these deeper sources.

In summary, the coal beds are areally the most extensive aquifers in common use. The clinker and alluvium on the other hand are the most permeable and thus permit higher individual well yields. Lenses of sandstone in the overburden and interburden are the least predictable and least used sources of ground water owing to their limited areal extent and near isolation in the subsurface by surrounding fine-grained rocks that have relatively low permeability.

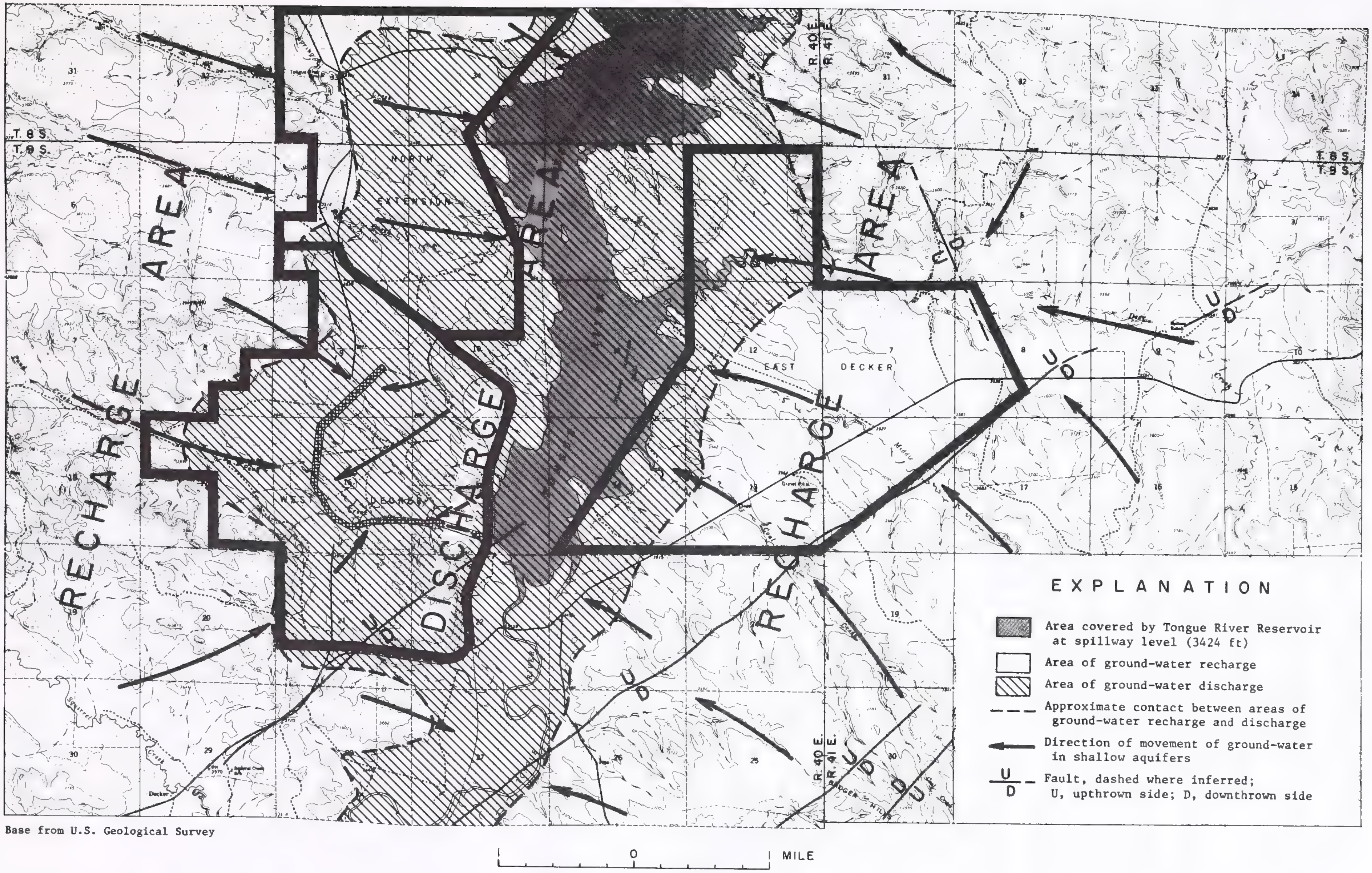
[1/] According to Baker (1929) this well was drill in the SE¼ sec. 16, T. 9 S., R. 40 E. The exact location is not important to this study.

(2) Movement of ground water

(a) Direction

The pattern of ground-water movement in the Decker area is strongly influenced by local topography. In general, movement follows the slope of the land surface, away from the topographically high interstream areas toward the Tongue River valley where most of the shallow ground water is discharged. This overall pattern of movement is modified in the western part of the area where the opening of the West Decker mine and attendant dewatering of the mine pit has created a new point of discharge in the ground-water system.

In addition to lateral directions of movement, ground water also tends to move downward in recharge areas and upward in discharge areas in response to hydraulic gradients. This is shown by waterlevel measurements in observation wells, most of which were installed by the Decker Coal Co. in conjunction with the ongoing ground-water study by the Montana Bureau of Mines and Geology (see tables D-2, D-3, and D-4, Appendix D). Of a total of 69 observation wells, 51 were placed in nests of two or more and completed in different aquifers to enable the determination of both lateral and vertical components of ground-water movement. Water-level data from these wells were used to prepare the map in figure 41 showing the approximate areas of recharge and discharge and the inferred direction of lateral ground-water movement. The areas of recharge correspond to areas where water-levels in nests of observation wells show a progressive decrease in head with increasing depth of aquifer. Areas of discharge reflect the reverse conditions. Arrows on the map indicate the directions of ground-water flow in selected aquifers.


RECHARGE AREA
DISCHARGE AREA
RECHARGE AREA
NORTH EXTENSION
WEST DECKER
EAST DECKER
T.8 S.
T.9 S.
R.40 E.
R.41 E.
U
D
0
MILE
EXPLANATION
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Area of ground-water recharge
Area of ground-water discharge
Approximate contact between areas of ground-water recharge and discharge
Direction of movement of ground-water in shallow aquifers
Fault, dashed where inferred; U, upthrown side; D, downthrown side

Base from U.S. Geological Survey

Figure 41.-Map of the Decker area showing approximate areas of ground-water recharge and discharge and direction of ground-water movement in shallow aquifers.

As shown by the directions of lateral movement indicated on figure 41, the influence of topography appears to be most pronounced on the movement of ground water in the alluvium and clinker. It appears to be least pronounced on the movement of ground water in the coal aquifers. This is attributed to the fact that water in the clinker is unconfined, whereas water in the coal is confined by overlying and underlying beds of shale, mudstone, or siltstone.

Other features that seem to influence ground-water movement in the Decker area are the orientation of faults and fracture systems that traverse the area. The displacement of rock units along fault planes constitutes abrupt interruptions in the physical, and thus, the hydraulic continuity of aquifers. As a result, movement of ground water across a fault plane tends to be impeded. Where fault planes are oriented parallel to the prevailing hydraulic gradient, the resistance offered to ground-water movement is not evident. Where the fault planes are oriented perpendicular to the gradient, however, the hydraulic effect of a fault can be appreciable. This is illustrated by the two faults on the margins of the proposed East Decker mine area. The fault that forms the southeastern margin of the area is essentially perpendicular to the prevailing hydraulic gradient. Water levels in observation wells on either side of the fault plane show an abrupt steepening of the prevailing hydraulic gradient across the fault plane (table D-3, Appendix D). This steepening indicates considerable resistance to the flow of ground water through the fault plane.

In contrast, the fault along the eastern margin of the proposed mine area is more nearly parallel to the prevailing direction of ground-water flow. Observations of water levels on either side of this fault do not reflect any noticeable steepening of the prevailing gradient. It should be noted, however, that the direction of the prevailing gradient very probably would be changed to a more westerly direction if the East Decker mine is opened. The fault then would tend to impede the flow of ground water toward the mine.

In the West Decker area the flow of ground water has been modified by excavation of the West Decker mine. The bottom of the mine is about 40 to 50 feet lower than the normal stage of the Tongue River Reservoir. Thus, the mine cut, which is kept dewatered at all times, has formed a ground-water sink or drain that is lower in altitude than the reservoir. As a result, hydraulic gradients have been established that induce ground water to move toward the mine from all directions. Significantly, the hydraulic gradient in the area between the mine and the reservoir has been reversed, causing ground water to move from the reservoir toward the mine.

(b) Rate

The probable rates of ground-water movement through the existing and proposed mining areas can be determined using standard equations for flow through porous media, provided the hydraulic coefficients of the aquifers are known. Values for the hydraulic coefficients of the coal aquifers have been reported by Van Voast and Hedges (1975, table 1), but none has been reported for the alluvium or clinker. Estimates of the hydraulic coefficients of the alluvium and clinker can be made, however, from knowledge of the saturated thickness and hydrologic character of these aquifer materials. In an attempt to bracket the actual values, both high and low estimates for the hydraulic coefficients of these materials were used in the calculations. The results of the calculations for each of the aquifers in the three mining areas are shown in table 12.

It is of interest to note that the estimated rate of ground-water movement through the aquifers in the North Extension area is much larger than that in either of the other two areas. This is attributed to the large amount of highly porous and permeable clinker in the North Extension area.

Some additional insight into the probable rates of ground-water movement in the Decker area can be deduced from field observations. For example, the West Decker mine completely penetrates the Anderson-Dietz 1 coal bed throughout the 12,000-foot length of the semicircular box cut. An analysis of mine pumpage data provided by the Decker Coal Co. reveals that the average rate of inflow into the box-cut attributable to ground-water discharge from the Anderson-Dietz 1 coal and from upward leakage from the Dietz 2 coal is about 25 gal/min (N. J. King, U.S. Geological Survey, oral communication). This value agrees favorably with the minimum estimated rate of ground-water movement cited in table 12.

Evidence to support the estimated high rate of ground-water movement in the North Extension area was obtained from observations in the valleys of Spring Creek and South Fork Spring Creek. Both streams flowed in their upstream and middle reaches during most of the late spring and summer of 1975 in response to abnormally high rainfall. Except for high runoff

Table 12. — — Estimated flow of ground water through the aquifers in the existing and proposed mine areas near Decker, Montana

Aquifer	Estimated flow[1/] ft³/s Low	ft³/s High	gal/min Low	gal/min High
West Decker area				
Anderson-Dietz 1 coal	0.07	0.10	30	45
Dietz 2 coal	.03	.04	15	20
Area subtotal	0.10	0.14	45	65
Proposed East Decker area				
Alluvium				
Deer Creek	0.22	0.33	100	150
Middle Creek	.02	.04	10	20
Coal Creek	.01	.02	5	10
Clinker	.17	.23	80	100
Anderson coal	.04	.07	20	30
Dietz 1 coal	.03	.05	15	25
Dietz 2 coal	.02	.03	10	15
Area subtotal	0.51	0.77	200	350
Proposed North Extension area				
Alluvium				
Spring Creek	0.01	0.02	5	10
Pearson Creek	0	.01	0	5
Clinker	1.35	2.40	600	1100
Anderson-Dietz 1 coal	.01	.02	5	10
Dietz 2 coal	.03	.05	15	25
Area subtotal	1.40	2.50	625	1150

[1/] Values rounded.

during and immediately following storm events, however, all flow was rapidly absorbed into the stream bed in those downstream reaches where the channels are underlain by clinker (fig. 32). Throughout most of June, for example, the entire flow of the South Fork, about 2 ft^3/s, was absorbed into the stream bed within a few thousand feet downstream from where the channel enters the clinkered area. No runoff reached the uppermost gaging station operated by the Decker Coal Co. on South Fork Spring Creek. On June 20-21, 1975, a low intensity storm yielding about 1 inch of precipitation occurred in the Decker area. Runoff records show that about 10 ft^3/s (4,500 gal/min) passed the upper station on South Fork Spring Creek and only about 6 ft^3/s (2,700 gal/min) reached the mouth, a distance of about 1¼ miles. During this same runoff event, no outflow occurred from the main fork of Spring Creek, which has a drainage area slightly larger than the South Fork. Thus, the rate of inflow or recharge to the clinker from these two streams probably exceeded 8 ft^3/s (4,000 gal/min) for a brief period.

(3) Discharge to the Tongue River Reservoir

As previously indicated, the Tongue River Reservoir represents the low point or sink into which the shallow aquifers discharge. The rate of discharge into the reservoir is strongly influenced by the stage or water-surface elevation of the reservoir. As the reservoir stage is lowered, the ground-water gradient is increased, thereby temporarily increasing the rate of discharge to the reservoir. When the stage rises, the ground-water gradient may be temporarily reversed, and water may move out of the reservoir into the surrounding aquifers. The normal direction of flow is restored when the ground-water gradient toward the reservoir is reestablished.

The long-term average rate of discharge into the reservoir from ground-water sources in the Decker area is estimated to be in the range of 4 to 6 ft^3/s (1,800-2,700 gal/min) or roughly 8 to 12 acre-feet per day. A significant percentage, perhaps as much as 70 to 80 percent, of this discharge enters the reservoir from the highly permeable clinker that lines the shores of the reservoir.

Most of the remaining ground-water discharge enters the reservoir as underflow from the alluvium that underlies the flood plains of the major tributaries to the reservoir. A large percent of this underflow is derived from other aquifers that are connected to the alluvium. Thus, the alluvium acts as a giant collector or lateral reaching into the uplands.

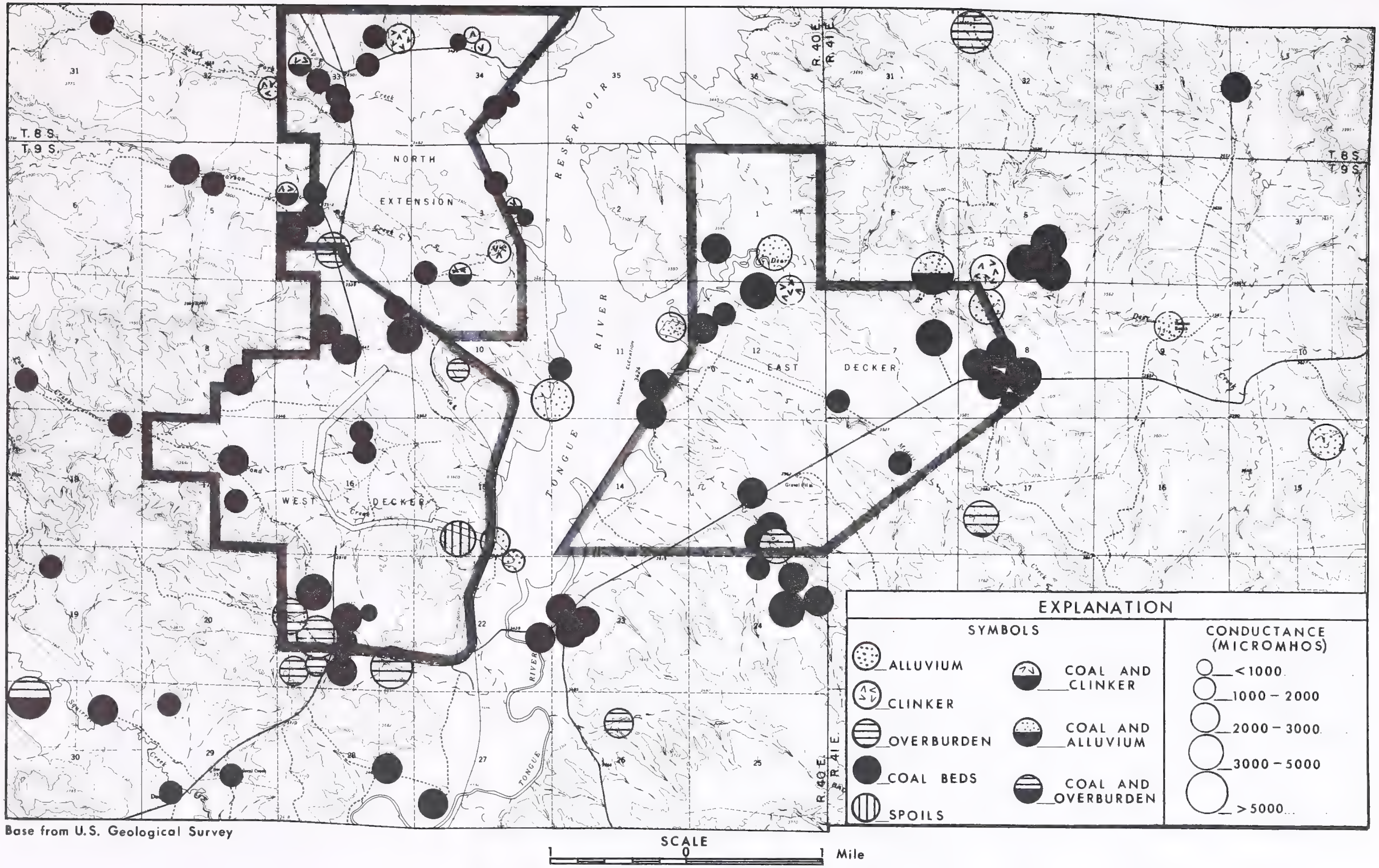
A very small percentage of total ground-water discharge to the reservoir is derived from the Anderson, Dietz 1 and Dietz 2 coal beds, despite the fact that these aquifers are believed to be connected with the reservoir through the alluvium that underlies the reservoir. The Anderson and Dietz 1 coal beds are undoubtedly in contact with the alluvium in the upper reaches of the reservoir. The Dietz 2 coal bed is presumed to be in contact with the alluvium underlying the lower reaches of both Spring Creek and Deer Creek valleys. The Canyon coal is probably not connected with the alluvium in this general area.

(4) Quality of ground water

To obtain information on the chemical quality of ground water in the Decker area, the Montana Bureau of Mines and Geology collected and analyzed samples of water from 34 wells in the area (Van Voast and Hedges, 1975, tables 3 and 4). Sixteen of these samples were collected from observation wells that were selectively completed in individual coal aquifers. The remaining 18 samples were collected from a representative number of privately owned wells of which a few obtain water from sources other than the coal aquifers. The U.S. Geological Survey has supplemented this information with numerous field determinations of temperature, pH, and specific conductance, which is a reliable indicator of the concentration of dissolved constituents in water.

Data on the quality of ground water in the Decker area indicate a wide range in the kind and concentration of dissolved constituents. In general, the chemical quality of the ground water differs markedly from one type of aquifer to another, and the concentration of dissolved constituents within a given type of aquifer often differs significantly from one part of the area to another as shown on figure 42.

Water from the coal aquifers is characteristically a sodium bicarbonate type. Its sodium adsorption ratio is among the highest of any waters in the area. The concentration of dissolved constituents ranges from about 675 to 3,400 mg/l with common values of between 1,500 and 2,500 mg/l. Differences in concentrations among individual coal beds in each of the three mine areas are indicated by the specific conductance data in table 13. These data show that water from the coal aquifers is usually less



Base from U.S. Geological Survey

Figure 42. -- Specific conductance of water from wells in the Decker area, Montana

Table 13.—— Summary of specific-conductance data on ground water in the Decker area, Montana

Source	No. samples	Specific conductance[1] (Micromhos/cm)	
		Range	Median
West Decker area			
Alluvium	3	1,650-2,450	2,000
Overburden	6	2,375-8,000	5,300
Anderson-Dietz 1 coal	22	1,620-3,600	2,000
Dietz 2 coal	8	930-2,100	1,600
East Decker area			
Alluvium	9	2,640-4,050	3,000
Clinker	3	2,450-4,600	2,890
Overburden	2	5,200-5,300	-
Anderson coal	13	900-3,550	2,625
Dietz 1 coal	15	980-3,800	2,450
Dietz 2 coal	7	950-3,700	2,750
North Extension area			
Clinker	5	775-3,550	1,725
Anderson-Dietz 1 coal	5	1,650-1,800	1,675
Dietz 2 coal	21	750-2,500	1,575
Canyon coal	8	830-2,350	1,400

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[1] To approximate dissolved solids content in mg/l, multiply specific conductance by 0.9

mineralized in the West Decker and North Extension areas than in the East Decker area. The median values indicate, with one exception, a decrease in mineralization in successively deeper coal beds.

In contrast, water from sandstone aquifers in the overburden is the most highly mineralized ground water in the area, suggesting that there is an abundance of soluble minerals in the overburden material and that ground-water circulation through these aquifers may be relatively slow. The dominant ions in solution are sodium, bicarbonate, and sulfate. Based on specific-conductance data (table 13), the concentration of dissolved constituents appears to range from about 2,100 to 7,200 mg/1. The median concentration exceeds 5,000 mg/1. Owing to its high mineralization and high sulfate content, water from the overburden is rarely used for other than watering stock.

Water in the clinker differs considerably in its chemical quality from place to place. Differences usually can be related to the chemical quality of the water entering the clinker as recharge rather than to differences in clinker type or time of travel in the aquifer. For example, where the clinker receives water directly from precipitation, the dissolved solids content is generally less than 750 mg/1 which reflects the minimal solubility of minerals in the clinker. In Spring Creek valley where overland runoff is known to enter the clinker, the dissolved-solids content of water in the clinker ranges from about 1,500 to 1,600 mg/1; practically the same as for water in Spring Creek. In the East Decker mine area, water in the clinker is fairly highly mineralized as shown by the specific conductance values given in table 13. Apparently the clinker in that area receives inflow mainly from aquifers containing comparatively poor-quality water.

The quality of water in the alluvium, like that in the clinker, is strongly influenced by the quality of the water that it receives as recharge. Owing to the variety of sources of recharge, however, the water in the alluvium is subject to considerable variation in quality from place to place. In the Deer Creek valley, water from the alluvium appears to be more highly mineralized than elsewhere in the Decker area (fig. 42). Specific-conductance values (table 13) indicate a dissolved solids content ranging from about 2,500 to nearly 4,000 mg/1. In contrast, water in the alluvium on the west side of the Tongue River Reservoir generally contains less than 2,000 mg/1 dissolved solids. Typically, water in the alluvium is very hard, indicating the presence of significant concentrations of calcium and magnesium. The hardness also indicates a low sodium adsorption ratio. Water from the alluvium, therefore, generally should be suitable for irrigation.

As ground water moves downward through the overburden into the coal aquifers, two chemical reactions tend to occur. One involves the exchange of sodium ions in the overburden for calcium and magnesium ions in the ground water. This reaction, called cation exchange softening (Riffenburg, 1925), helps explain the dominance of sodium in the waters from the coal and from the overburden.

The other reaction helps explain the reduction in sulfate content that occurs as water moves from the overburden materials into the coal aquifers. In the presence of hydrocarbons and certain bacteria, sulfate, which is otherwise chemically stable, may be reduced to form hydrogen sulfide and bicarbonate (Hem, 1970, p. 170).

Indications that this reaction does occur at the interface between the coal beds and the overburden in the Decker area are evidenced by the apparent reduction in the sulfate content and the presence of noticeable amounts of hydrogen sulfide gas in water from the coal aquifers. The presence of hydrogen sulfide gas is most prevalent in wells finished in the shallowest coal aquifer in recharge areas.

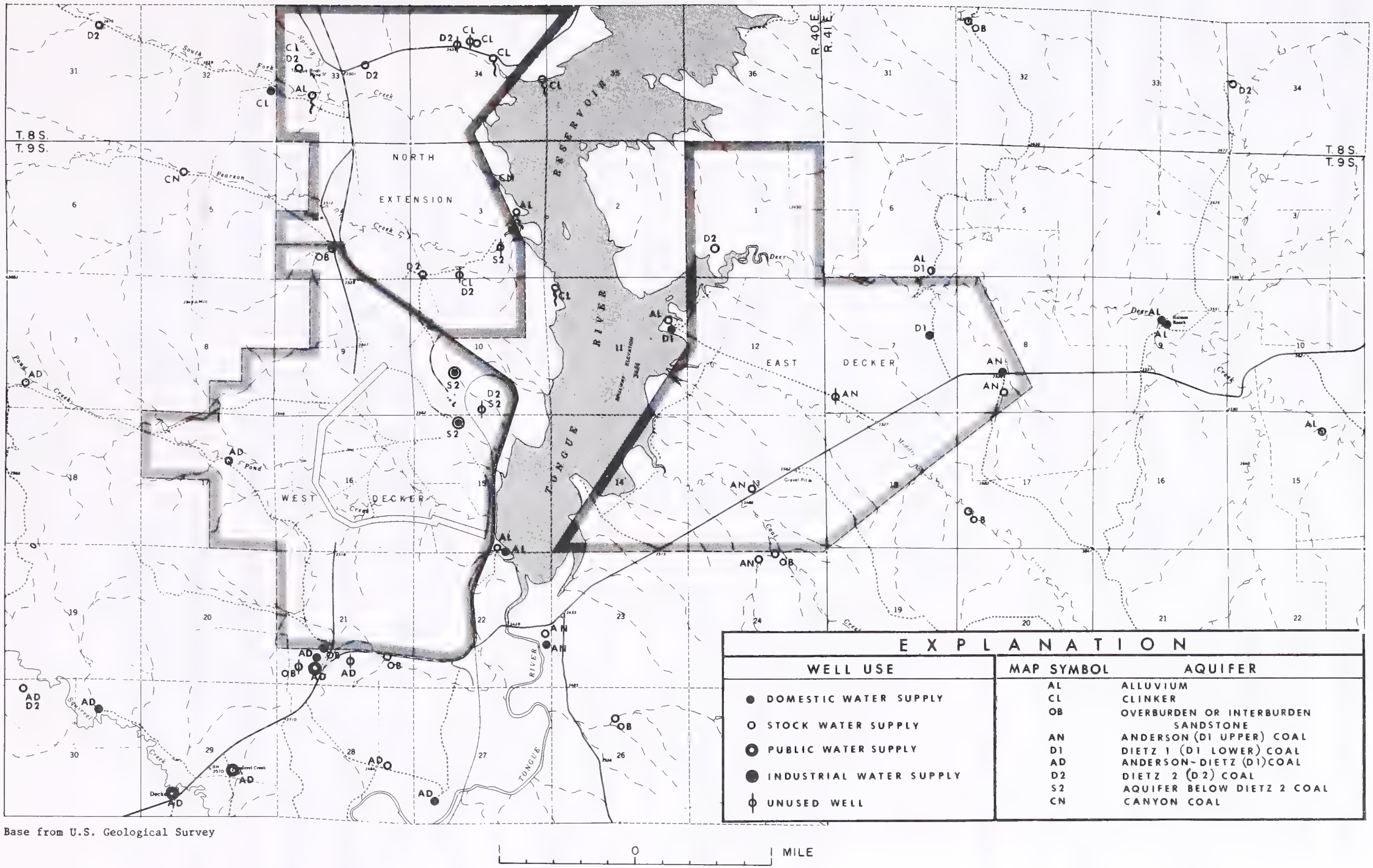
Radiological contamination of water supplies does not appear to be a problem in the Decker area. Monitoring of mine-effluent discharge from the West Decker mine by the Decker Coal Co. in accordance with standards established by Montana Department of Health and Environmental Sciences indicates levels of gross alpha and beta particle radioactivity significantly below the maximum levels permitted by the U.S. Environmental Protection Agency (EPA) under Federal Regulations 40 C.F.R. 141.15 and 141.16. An effluent sample collected on September 1, 1976, by the U.S. Geological Survey and analyzed in its laboratories in Denver, Colorado, showed combined radium radioactivity, which is considered a more reliable indicator than gross alpha and beta radioactivity, of only 0.16 picocurries per liter (pCi/l). This level is significantly less than the maximum of 5 pCi/l permitted by EPA.

(5) Use of ground water

The average daily use of ground water in the Decker area is estimated to range from about 20,000 to 30,000 gallons per day. This amount is equivalent to about 15 to 20 gallons per minute, or less than 1 percent of the ground water discharging into the Tongue River Reservoir from the area.

Perhaps as much as 25 percent of the total ground water withdrawn is used for watering stock. An equal amount probably is used by residents in the area for domestic purposes. The remaining amount is tentatively attributed to use for industrial and sanitation purposes at the West Decker mine and for general public use at the few commercial establishments in the area. Most of these ground-water supplies are obtained from wells, but some use by livestock and wildlife is made of water from springs. All wells and springs that have been inventoried in the area are tabulated in Appendix D. The location, aquifer source, and use of these wells and springs are shown on figure 43.

About two-thirds of the wells are used for watering livestock. Generally these wells were completed in the shallowest aquifer that would supply the required amount of water, without regard to the quality of the supply. Many are in remote areas and are pumped only during the summer season. A comparatively few are still powered by windmills, but most are powered by internal combustion engines or by electrically powered pumps that are operated intermittently as needed. Total pumpage for stock-watering purposes varies with the number of livestock in the area and the availability of surface-water supplies. Although the number of livestock in the area tends to fluctuate from season to season and from year to year, the average probably does not exceed 1,000 head. If the rate of consumption per head is assumed to be 10 gallons per day, and if half of the water used by livestock is obtained from surface-water supplies, the total withdrawal from ground water for stock-watering purposes probably does not greatly exceed 5,000 gallons per day. Corresponding use of ground water by wildlife is small.



Base from U.S. Geological Survey

Figure 43. - Map of the Decker area showing the locations of wells and springs used as a source of water supply.

Wells used for domestic, public, and industrial supplies are generally finished in coal aquifers, because the water is characteristically soft, free of iron, and less mineralized than that from most other aquifers. Usually these wells are equipped with electric-powered pumps that turn on and off automatically in response to water demand. Hence, these wells are pumped for brief periods each day of the year. It is estimated that the population served by wells in the Decker area probably does not exceed 100 and their per capita use might range from 60 to 100 gallons per day.

(6) Long-term effect of the West Decker mine on ground water

The impact of the first three years of operation of the West Decker mine on ground water has been appraised by Van Voast and Hedges (1975). Most significantly, they conclude that the operation of the mine has lowered water levels about 40 feet in the Anderson-Dietz 1 coal and about 15 feet in the Dietz 2 coal in the immediate vicinity of the mine. Northwest, west, and southwest of the mine declines have been about 10 feet within a radius of 1.5 to 1.75 miles. Water-level declines east of the mine have been much less because of recharge from the nearby Tongue River Reservoir.

As mining proceeds to the south and west, some additional lowering of water levels in the Anderson-Dietz 1 and the Dietz 2 coals can be expected in response to the removal of additional ground water from storage. As noted by Van Voast and Hedges (1975, p. 13), the rates of water-level decline should not be as severe in the future as has been observed in the past. Generally, the slope of the hydraulic gradient toward the mine should remain the same, but the area of maximum water-level decline in the coal aquifers will expand as the mine progresses southward and westward. As in the past, however, the sandstone aquifers in the overburden will not be greatly affected unless or until the mine actually exposes one of these isolated aquifers. At such time, the highly mineralized water in the exposed aquifer would probably drain relatively quickly into the mine, thereby removing from service any wells that might obtain water from the intersected sandstone.

Continued operation of the mine should not cause any additional changes in the direction of ground-water movement. The rate of inflow, however, is almost certain to increase if mining exposes more saturated clinkered material along the eastern margin of the mine near the western shore of the reservoir. This is demonstrated by a series of measurements of the rate of inflow issuing from the clinkered material under different mining conditions and reservoir stages. For example, in October 1974, when only a few tens of feet of clinkered material were exposed at the northeast end of the initial scraper pit at the southeast end of the mine, 140 gal/min having a dissolved solids content of about 1,375 mg/1 were measured flowing into the mine through the clinker. In July 1975, after the area of exposed clinker had been widened to several hundred feet, the rate of inflow through the clinker had increased to 290 gal/min, more than double the previous measurement. The dissolved-solids content had dropped to about 1,160 mg/1. In late September 1975, when the stage of the Tongue River Reservoir was about 20 feet below the spillway elevation of 3,424 feet, the rate of inflow to the mine from the clinkered material had decreased to 120 gal/min. The dissolved-solids content was about 1,120 mg/1. Thus, future rates of inflow to the mine from the reservoir through the clinkered material can be expected to increase in proportion to the exposed area of saturated clinker and to fluctuate in response to reservoir stage.

Just how much the rate of inflow into the mine from the clinkered material will increase as mining progresses depends mainly on the width and saturated thickness of clinkered material exposed by mining. It is possible that the rate of inflow will increase by as much as 100 gal/min for each additional 100 feet of saturated clinker exposed in the mine cut. Regardless of the amount, any increased inflow to the mine will not reduce the supply available from the nearby reservoir because inflow will be returned to the reservoir as mine effluent.

Van Voast and Hedges (1975, p. 14) report that the chemical quality of the mine effluent water has changed significantly between the beginning of mining in mid-1972 and early 1975. Continuing analysis of effluent quality by the Water Quality Bureau, Montana Department of Health and Environmental Sciences, substantiates most of Van Voast's and Hedges' conclusions through July 1975. Concentrations of HCO_3, Na, SO_4, and the calculated sodium adsorption ratio (SAR) have decreased over time. For example, initial SAR values of more than 20 have decreased to about 8, as of mid-1975. Total dissolved solids concentrations have also decreased from mid-1972 concentrations of between 1,750 and 2,250 mg/1. Two effluent samples collected in July 1975, showed concentrations of 1,358 and 1,534 mg/1. These changes appear to be the result of mixing increased amounts of inflow from the clinkered material with smaller, nearly constant amounts of inflow (about 25 gal/min) from the coal aquifers. With continually increasing amounts of inflow from the clinker, the quality of the mine effluent should approach that of the inflow from the clinker. As most of this water is believed to be induced infiltration from the Tongue River Reservoir, the quality of the mine effluent, therefore, can be expected to approach that of the reservoir. Some increase in mineralization will doubtless occur as the water from the reservoir passes through the alluvium and clinker before it reaches the mine pit. Hence, the concentration of dissolved constituents in the mine effluent in future years probably will range between 1,000 and 1,500 mg/1. Sodium and bicarbonate will probably continue to be the principal ions in the mine effluent. The sodium absorption ratio might be further reduced to less than 5 owing to the possible increase in the percent of calcium and magnesium in the inflow from the clinkered material.

If during future mining operations overburden spoils are interposed between the clinkered material and the mine pit, the quality of mine effluent water very probably would be adversely affected. Under these conditions, the relatively lowly mineralized water issuing from the clinker would be exposed to soluble constituents in the spoils before reaching the mine pit. Consequent leaching would cause a sizeable increase in the sodium and sulfate content of the mine inflow. Conceivably, the total concentration of dissolved solids in the inflow might be doubled or tripled and the sodium adsorption ratio might rise above 10.

Some reduction in seepage from the reservoir might occur as the volume of spoils placed between the clinkered material and the active pit increases. Observations indicate, however, that the coarse rubble at the base of the spoils (fig. 44) should be moderately to highly permeable, at least initially. The damming effect of the spoils, therefore, probably would not significantly reduce inflow to the mine.

The hydrologic effects of the operation of the West Decker mine will continue for some period of time after mining operations have ceased. The first event will be a cessation of outflow from the final mine cut to the reservoir when pumping ceases. Inflow from the reservoir to the mined-out area will continue at a progressively decreasing rate, however, until a sufficient amount of water has been returned to ground-water storage to raise the level of saturation in the mined area to about normal reservoir level. Thereafter, surface-water infiltration and ground-water recharge from the south and west will continue until the normal or premining ground-water gradient across the mine area to the reservoir is reestablished. This will require raising the level of saturation in the reclaimed spoils and dewatered coal beds to a point above the normal pool of the reservoir. Depending on the rate of replenishment, several years might be required to replace the needed volume of ground-water storage.

Once ground-water storage is replaced and the premining gradient toward the reservoir is reestablished, the discharge of ground water across the mined area to the reservoir would be restored. The rate of discharge might be expected to equal the premining flow rate of about 25 gal/min. According to Van Voast and Hedges (1975, p. 25), the increase in volume of

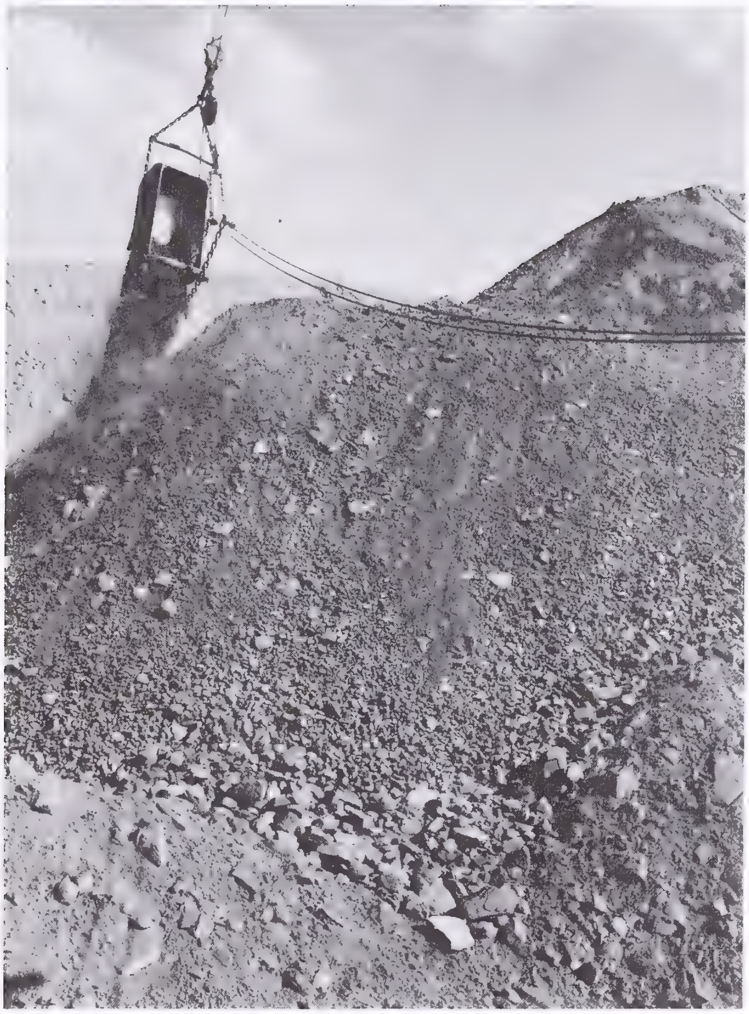


Figure 44.-Typical spoils pile formed by excavation of overburden with a dragline. Note the coarse rubble formed by boulders rolling to the base of the pile.

about 25 percent, which occurs when the overburden is broken and rearranged as spoil, is very likely accompanied by increases in porosity and hydraulic conductivity for the materials. Although the character of the aquifer now being created at the West Decker mine is not yet known, very probably the coarse rubble layer at the base of the spoils would easily transmit all ground water moving through the mined area. The chemical quality of the discharge, however, would have been significantly altered by the leaching of soluble substances in the mine spoils. Perhaps, the best characterization of the chemical quality of the postmining ground-water discharge is that it probably will be similar in quality to ground water locally available from the overburden sandstone aquifers. If so, water discharging to the reservoir can be expected to contain about 5,000 mg/1 dissolved solids and to have a high (over 10) sodium adsorption ratio. Water samples from two observation wells recently completed in reclaimed spoils materials in the West Decker mine (table D-2, Appendix D) contain about 4,300 mg/1 dissolved solids. Regardless of the change in quality of the postmining ground-water discharge, however, the rate of discharge will be so small as to have an insignificant effect on the quality of water in the Tongue River Reservoir (see section III. C. 3. (5)).

b. Surface water

Surface waters in the Decker area include: (1) the Tongue River Reservoir, (2) the Tongue River, (3) flows in streams, most of which are ephemeral, that drain upland areas in the vicinity of the reservoir, and (4) waters derived from past and present mining operations in the area. Included in the discussion of ephemeral streams is a description of small impoundments and natural standing pools in some stream channels.

As may be inferred from the description of the climate, surface waters in the Decker area vary widely in quantity and quality, both annually and seasonally. For example, about 90 percent of the inflow to the Tongue River Reservoir is from surface runoff from the Bighorn Mountains. This runoff is derived largely from snowmelt and varies greatly, depending on the volume of water contained in the annual snowpack. In marked contrast, most flows in ephemeral streams and consequent erosion and sediment movement off the upland areas adjacent to the reservoir occurs in response to high-intensity summer thunderstorms. Least variable are waters derived from past and present mining operations, which discharge intercepted ground water.

(1) Tongue River Reservoir

(a) Description and operation

Water in the Tongue River Reservoir is impounded by a dam across the Tongue River valley about 10 miles north of the Montana-Wyoming line (figs. 23 and 45). Engineering data for the dam and spillway are given in Appendix D. The reservoir is used primarily as a water-storage facility for downstream irrigation in the Tongue River valley. Recreation is an important secondary use.

The Tongue River Reservoir Project was financed by a loan and grant from the Public Works Administration and by funds from the Montana State Water Conservation Board, predecessor of the Department of Natural Resources and Conservation. Construction was completed in 1940. At spillway level (3,424 feet) the reservoir floods an area of about 3,500 acres. This area and about 2,325 acres of land surrounding the reservoir are deeded to the State of Montana. The project is currently administered by the Department of Natural Resources and Conservation and operated by the Tongue River Water Users Association. A dam tender is employed by the Water Users Assocation.

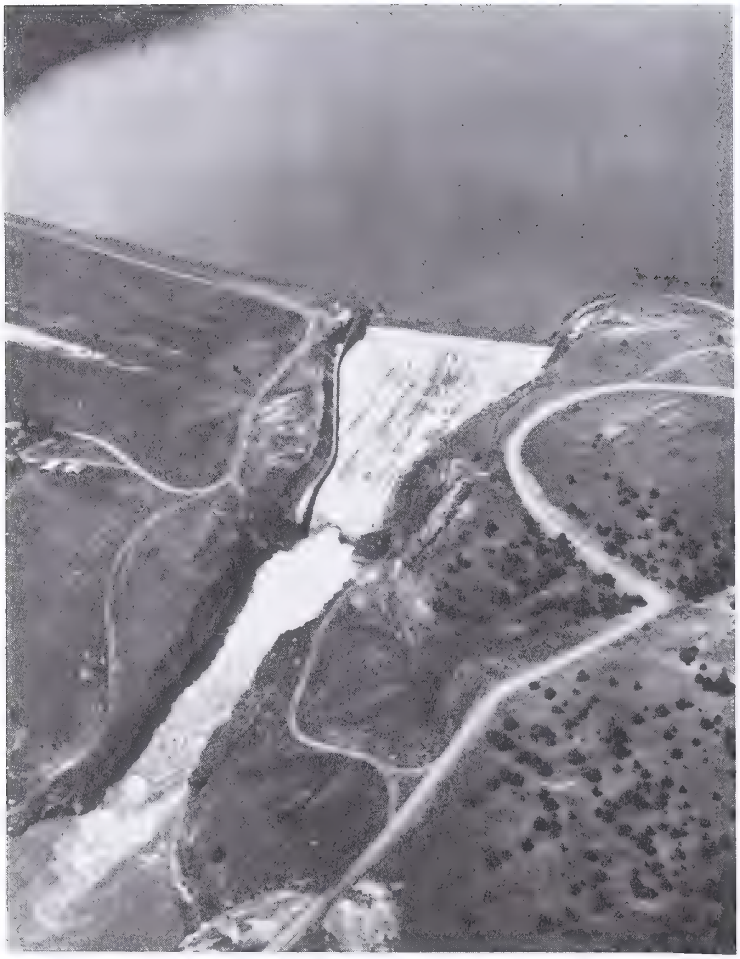


Figure 45.-Tongue River dam and emergency spillway showing outflow from the reservoir through the outlet tunnel.

Outflow from the reservoir is normally through a concrete tunnel (fig. 45) 16 feet in diameter, the opening to which is controlled by an operating gate that is raised and lowered by motor-driven cables. An emergency gate immediately upstream from the operating gate can be used, if necessary. Overflow through the emergency spillway (for description see engineering data, Appendix D) has occurred rarely since completion of the structure. Changes in the rate of outflow are made by the dam tender in response to the needs of downstream users or as required during periods of excess runoff.

(b) Capacity and water use

According to Dendy and Champion (1973), the initial capacity of the Tongue River Reservoir in May 1939 was about 72,500 acre-feet. By October 1948, sediment deposition had decreased the reservoir capacity to about 69,400 acre-feet, an annual decrease in capacity of about 330 acre-feet. No reservoir resurveys have been made since 1948; however, assuming no appreciable change in sediment yield from the watershed, the present (1975) capacity of the reservoir should be about 60,000 acre-feet.

Most water from this project is used during the period May 1 to October 1 to irrigate hay and alfalfa fields in the Tongue River valley downstream. About 15,000 acres are irrigated between the dam and Miles City. Most water is pumped or diverted from the river into distribution ditches and laterals. Very little use is made of sprinkler irrigation systems. Comparatively little water has been used for industrial purposes, a use that undoubtedly will receive greater emphasis in the future. The U.S. Department of the Interior, Fish and Wildlife Service uses 650 acre-feet annually for fish cultural purposes at the Miles City National Fish Hatchery. The

Montana Power Company has contracted for 4,175 acre-feet annually, but no use has been made of this water to date.

(c) Quantity of water

Estimated average annual inflow to the Tongue River Reservoir from the Tongue River and from streams draining the upland adjacent to the reservoir is summarized in table 14.

As shown in table 14, expected average annual inflow to the Tongue River Reservoir is about 362,000 acre-feet. Average annual evaporation from the reservoir surface should be about 28 inches (p. 106), or about 7,000 acre-feet. Average annual flow through the reservoir, therefore, should be about 355,000 acre-feet. It should be stressed, however, that runoff during many years will be less than average. In the period 1961-70, annual discharge of the Tongue River at the State line ranged from 136,000 acre-feet in 1961 to 481,000 acre-feet in 1970. The effect of these variations in inflow coupled with irregular water demands downstream are reflected in figure 46, which shows minimum, average, and maximum reservoir storage for the period 1956-75. Data used to prepare this illustration are listed in Appendix D. The Montana Department of Natural Resources and Conservation reports that the estimated firm annual yield of the Tongue River Reservoir is about 40,000 acre-feet. Virtually all of this water has been sold.

(d) Chemical quality of water

The chemical quality of water in the Tongue River Reservoir closely approximates that of water in the Tongue River, which contributes approximately 98.7 percent of all inflow to the reservoir. The chemical quality of water in the Tongue River is summarized on page 194.

Table 14.--Estimated average annual runoff and sediment yield to the Tongue River Reservoir

Source	Drainage area		Average annual runoff		Average annual sediment yield		
	Square miles	Percent of total	Acre-feet	Percent of total	Acre-feet	Tons[1]	Percent of total
ongue River at state line[2]	1,480	83.6	357,000	98.7	238	363,000	72.5
phemeral streams traversing the East Decker area[3]	62	3.5	[4] 1,040	.3	19	29,000	5.8
phemeral streams traversing the North Extension area[3]	48	2.7	[4] 640	.2	18	27,000	5.5
her tributaries	180	10.2	2,900	.8	53	81,000	16.2
otal	1,770	100	[5] 362,000	100.0	328	500,000	100.0

/ Sediment weight assumed to be 70 lbs/ft^3.

/ Flow in the Tongue River is discussed on p. 191

/ Flow in ephemeral streams is discussed on p. 195

/ See table 15.

/ Total rounded to three significant figures.

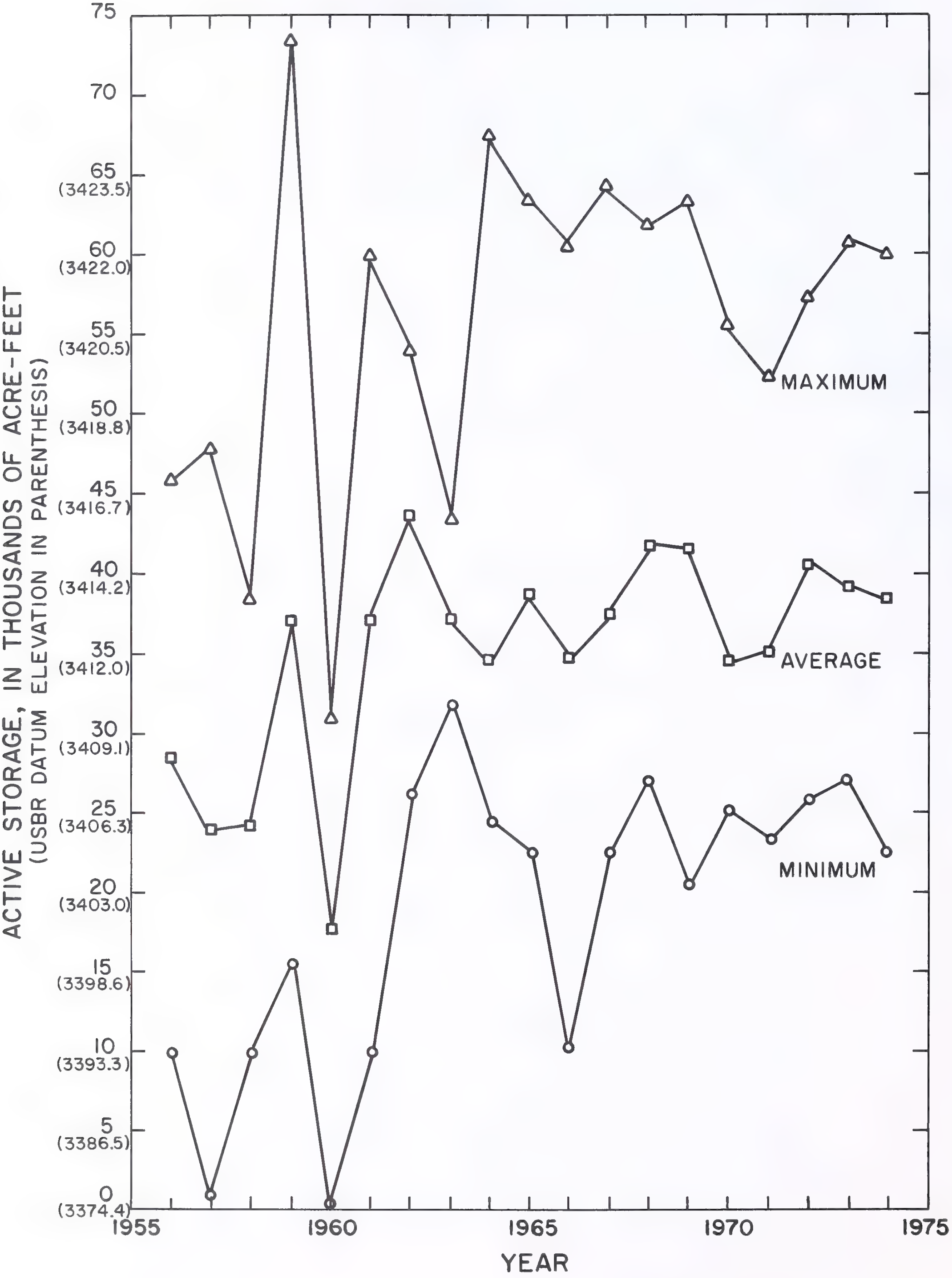


Figure 46.--Annual fluctuations in storage in the Tongue River Reservoir, 1956-74.

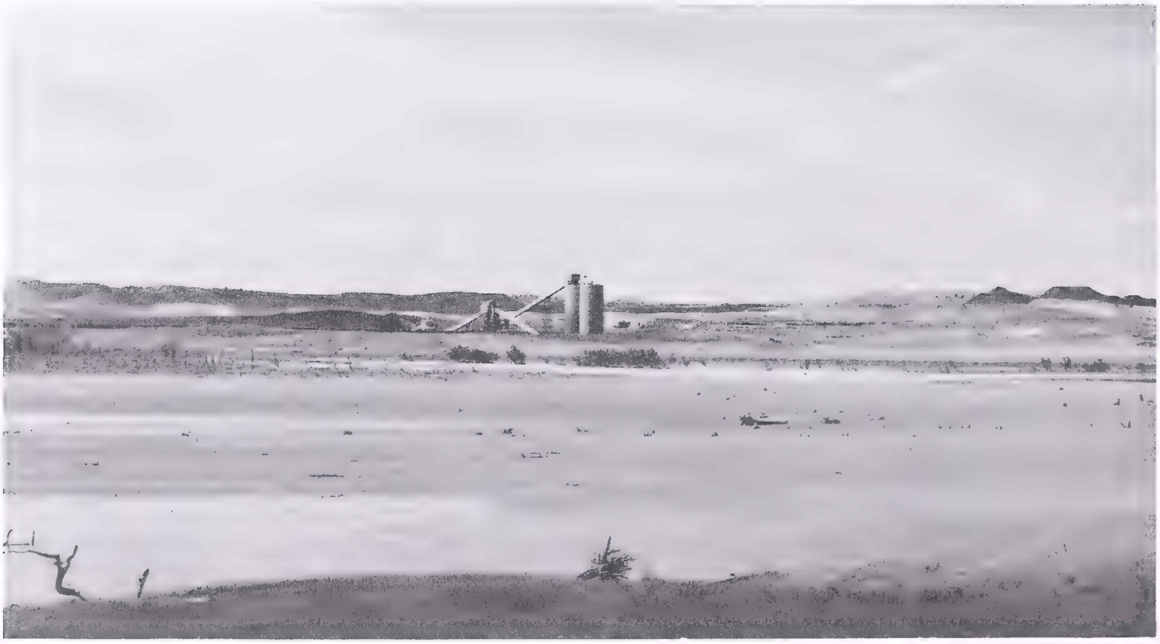
(e) Sediment

As previously stated (p. 185), average annual sediment deposition in the Tongue River Reservoir during the period May 1939 to October 1948 was about 330 acre-feet (Dendy and Champion, 1973). Using an estimated density of 70 lb/ft^3, this represents an annual sediment yield to the reservoir of about 500,000 tons. Assuming average annual runoff to the reservoir to be about 362,000 acre-feet (table 14), sediment concentration of the inflow would be about 1,000 mg/1. Estimated average annual sediment yield to the Tongue River Reservoir by source areas is given in table 14.

Analyses of samples of outflow from the reservoir collected on June 21, June 29, and July 18, 1975, showed sediment concentrations of 14, 41, and 32 mg/1 respectively at discharges of 3,490, 4,190, and 1,280 ft^3/s. On July 18, at a time when approximately 100 tons of sediment per day was being carried out of the reservoir, the surface of the reservoir was clear, showing no discoloration from suspended sediment. Apparently, therefore, suspended sediment is moving at depth through the reservoir.

The suspended-sediment content of water in the reservoir is notably increased following periods of high inflow and on windy days when wave action erodes both the shoreline and the extensive sediment deposits in the shallow upstream part of the reservoir basin (fig. 47). Seasonal fluctuations of the reservoir water level prevent establishment of a protective plant cover on these eroding areas. The water surface tends to clear within a few days after sediment inflow or wave action ceases, but apparently sediment remains suspended at lower levels in the reservoir for at least several weeks.

A. Reservoir in June 1975. Water surface is at spillway level (3,424 feet). This part of the reservoir generally is flooded only a few months each year.



B. Reservoir in September 1975. Typical appearance during late summer and fall when the reservoir water level is lowered to supply irrigation water downstream.

Figure 47.-View from the East Decker area westward across the upper part of the Tongue River Reservoir toward the West Decker mine.

(2) Tongue River

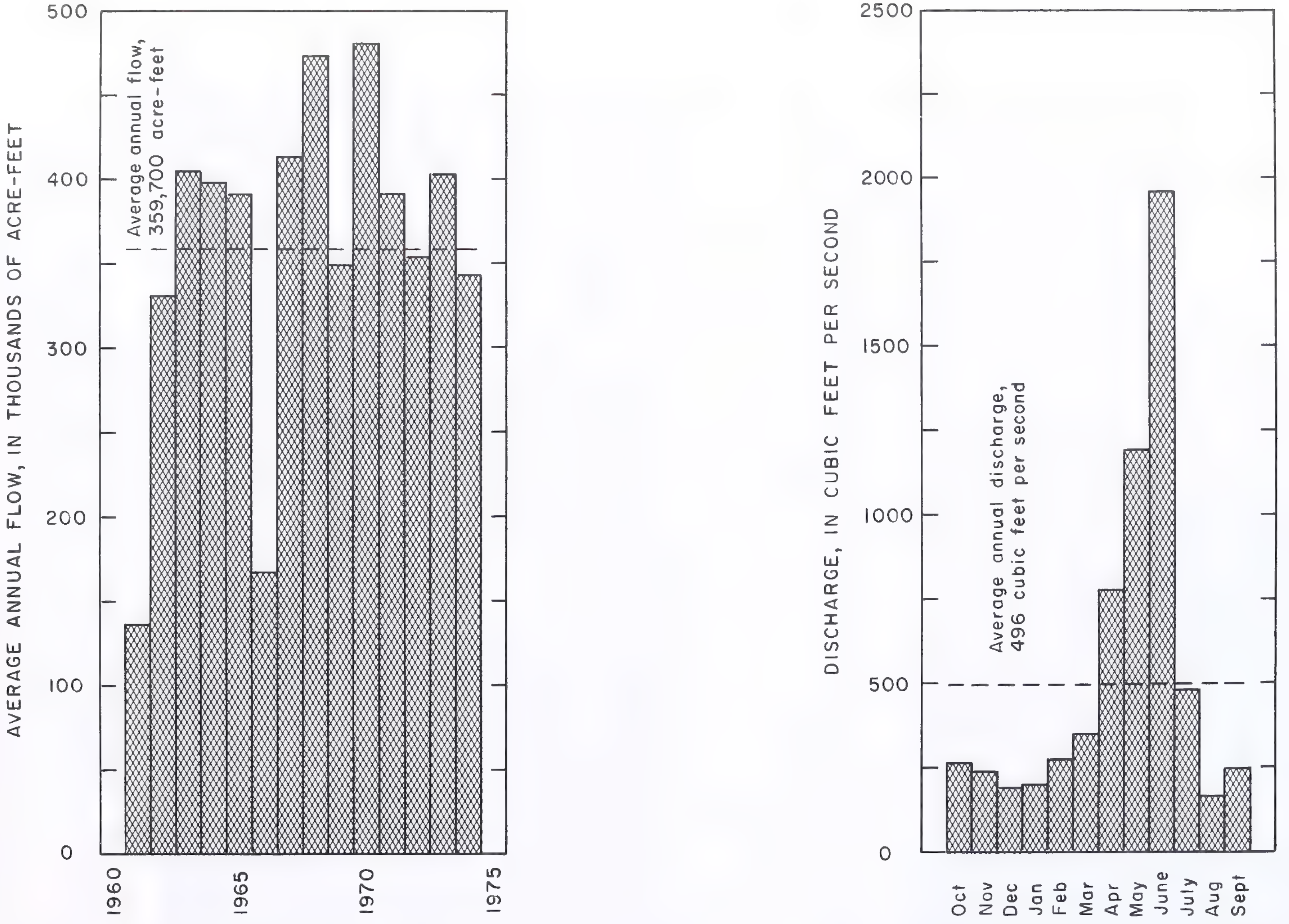
(a) Quantity of water

Surface-water measurements by the U.S. Geological Survey have been made on the Tongue River in the reach upstream from the reservoir since August 1960. The gaging station is in the NW¼NE¼ sec. 33, T. 9 S., R. 40 E., about a mile north of the Montana-Wyoming State line and about 1.4 miles southeast of Decker in Big Horn County, Montana. The drainage basin upstream from the station has an area of about 1,480 square miles. A number of small reservoirs in Wyoming, having a combined capacity of about 15,000 acre-feet, partially regulate the flow in the Tongue River at the gage. Water diverted upstream from the Tongue River Reservoir is used to irrigate about 64,800 acres.

Data reported by Dendy and Champion (1973) show the average annual flow (1939-48) to have been about 290,000 acre-feet. U.S. Geological Survey gaging station records (1960-74) show an average discharge of 496 ft^3/s (359,400 acre-ft/yr). Annual flow during this period ranged from a low of about 136,000 acre-feet in 1961 to a high of about 481,000 acre-feet in 1970 (fig. 48 A). Maximum discharge of 7,480 ft^3/s occured June 15, 1967; minimum discharge of 3.0 ft^3/s occurred August 23, 1961. Figure 48 B shows the average monthly discharge of the Tongue River for the 1961-70 water years; figure 49 shows the flow-duration curve.

(b) Chemical quality of water

Chemical quality of water measurements have been made at the above station since 1965. A summary of record for the period October 1, 1965 to September 30, 1969, is given in the following table.



A. AVERAGE ANNUAL FLOW

B. AVERAGE MONTHLY DISCHARGE

Figure 48.—Graphs showing average annual flow and average monthly discharge of the Tongue River at State line, 1961-74 water years (Data from U. S. Geological Survey, Water Resources Division).

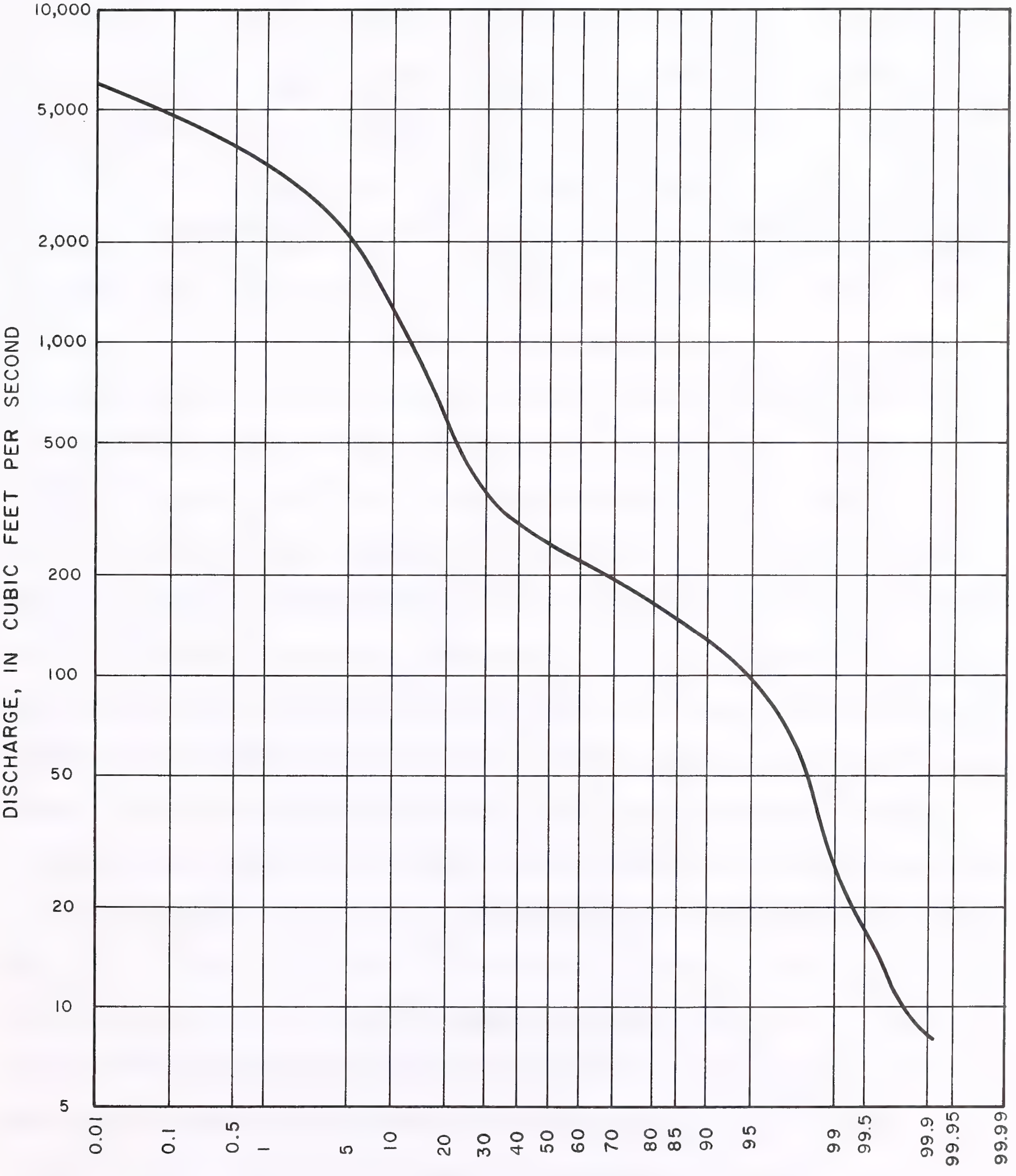


Figure 49. — Flow-duration curve for Tongue River at State line, 1961-73 water years.

Analysis	Range[1]	Mean[1]
Calcium	25-99	55
Magnesium	4.6-85	42.4
Sodium	7.4-110	35
Bicarbonate	103-321	224
Sulfate	8.5-530	190
Chloride	0-12	4.3
Flourine	.2-.6	.4
Nitrate	0-5.9	.9
Dissolved solids	152-1,000	471
Specific conductance	253-1,379 um/cm	690 um/cm
Hardness	110-580	311
Sodium adsorption ratio (SAR)	0.250-2.76	1.22

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[1] All units in mg/1 unless indicated otherwise.

(c) Sediment

No records of sediment discharge are available for the Tongue River in the Decker area, either upstream or downstream from the reservoir. Approximations based on runoff records and on sedimentation rates in the Tongue River Reservoir reported by Dendy and Champion (1973) indicate an average sediment concentration (suspended load plus bed load) of about 750 mg/1. Concentrations of less than 100 mg/1 probably occur during periods of high runoff. Highest sediment loads with concentrations possibly exceeding 5,000 mg/1 probably occur in runoff generated by high-intensity summer storms of appreciable areal extent.

(3) Ephemeral streams

The East Decker area is traversed by Deer, Middle, and Coal Creeks; the North Extension area is traversed by Spring and Pearson Creeks; and the West Decker mine lies in the Pond Creek drainage basin (fig.24). These streams are ephemeral throughout their lengths, although Deer Creek commonly flows in its central reach during the spring and early summer months. Similarly, Spring Creek and its largest tributary, South Fork Spring Creek, commonly flow in their upper reaches until early summer. During unusually wet years, such as 1975, small flows in Deer and Spring Creeks may persist through the summer in the middle and upper reaches. Runoff from the Pond Creek watershed upstream from the West Decker mine is diverted northeastward through a diversion ditch into a tributary of Pearson Creek. (p.201).

(a) Quantity of water

No runoff records are available for streams in the Decker area from which to calculate annual runoff from the various watersheds. Gaging stations have been established (1975) by the Decker Coal Co. on most of the principal streams traversing the proposed mine areas (figs. 70 and 72), but records to date are not adequate for analyses. Estimates of average annual runoff, therefore, are necessarily based on a qualitative comparison of watersheds in the Decker area with similar areas elsewhere in eastern Montana where runoff data are available. On that basis, annual runoff from ephemeral drainage basins in the Decker area probably ranges from about 0.1 to 0.5 inch and averages about 0.3 inch (Busby, 1966). This is the amount of runoff which, if spread uniformly over the entire watershed, would have a depth of 0.3 inch. Unit runoff is expected to be greater than average in the smaller watersheds having steeper gradients, such as those drained by Middle, Coal, and Pond Creeks, and to be less than average in watersheds underlain by large areas of permeable clinker, such as those drained by

Spring and Pearson Creeks. Table 15 gives the area drained by the principal ephemeral streams in the Decker area and the estimated annual runoff.

(b) Flood-peak discharges

Three methods were used to approximate the maximum or peak discharges in the above streams to the proposed mine areas from storms having recurrence intervals of 2 to 100 years. They are (1) the Montana flood-frequency analysis (Johnson and Omang, 1975); (2) computation from measurements of channel width (Barnes, 1975; Hedman, Moore, and Livingston, 1972; Riggs, 1974); and the rational method. Peak discharges for recurrence intervals up to 100 years (table 16) represent the averages of the results obtained from these methods. The inferred peak discharge from a 1,000 year storm was calculated using the rational method after graphically extending the available precipitation data to approximate the magnitude and intensity of a storm having a recurrence interval of 1,000 years. Assumptions and basic data used in these computations are given in Appendix D. The probability that a flood of given recurrence interval (table 16) will be exceeded in a specific time period is indicated in table 17.

Estimated peak discharges in table 16 are substantiated in part by data collected by the U.S. Geological Survey at a crest-stage gage established on Spring Creek immediately upstream from Route FAS 314 (fig.70). Annual peak discharges for the period 1958-74 are reported in table D-13 (Appendix D). Unfortunately, however, these data are insufficient for a detailed flood-frequency analysis for the Spring Creek watershed because of the relatively short period of record and because of the extreme variability of precipitation

Table 15.--Area of watershed and estimated annual runoff from principal ephemeral streams in the Decker area

Name	Area of watershed (square miles)			Estimated annual runoff prior to mining (acre-feet)[1]	
	In project area	Upstream from project area	Total	To project area	To Tongue River Res.
			East Decker area		
Deer Creek	4.2	49.1	53.3	790	850
Middle Creek	1.8	4.5	6.3	96	130
Coal Creek	.8	2.1	2.9	50	60
			North Extension area		
Spring Creek	1.2	35.7	36.9	480	490
Pearson Creek	1.0	7.5	8.5	[2] 80	[2] 90
			West Decker area		
Pond Creek	3.3	[3] 2.8	6.1	[3] 60	130

[1] Computed using average annual runoff for watersheds as follows: Deer Creek -- 0.3 inch; Middle, Coal, and Pond Creeks -- 0.4 inch; Spring Creek -- 0.25 inch; and Pearson Creek -- 0.2 inch.

[2] Does not include runoff from Pond Creek watershed.

[3] Runoff from Pond Creek watershed upstream from the West Decker project area is diverted into a tributary of Pearson Creek.

Table 16.--Estimated peak discharges in ephemeral streams at the upstream boundary of the proposed mine areas where diversions would be constructed

Watershed	Discharge, in cubic feet per second for the indicated recurrence intervals						
	2 years	5 years	10 years	25 years	50 years	100 years	1,000 years
Deer Creek	270	730	1,200	2,000	2,700	3,600	10,000
Middle Creek	60	200	350	630	890	1,200	3,500
Coal Creek	50	150	260	440	630	840	3,000
Spring Creek	210	570	970	1,600	2,200	2,900	10,000
Pearson Creek	80	260	450	700	1,100	1,500	5,000
Pond Creek diversion	60	180	300	530	750	1,000	------
Area of 0.5 mi^2	---	---	-----	-----	-----	-----	950
Area of 1.0 mi^2	---	---	-----	-----	-----	-----	1,800

The probability that a flood of given recurrence interval (table 16) will be exceeded in a specific time period is indicated in table 17.

and consequent runoff during this period (fig.30). A graphic plot of the data reported in table D-13 shows no well-defined flood-frequency curve for Spring Creek.

Table 17.-- Probability of a flood of given recurrence interval being exceeded during the indicated time periods (Davis, 1974)

Recurrence interval (years)	Probabilities for indicated time period in years				
	5	10	25	50	100
5	0.67	0.89	0.996	1.0[1]	1.0[1]
10	.41	.65	.94	.995	1.0
25	.18	.34	.64	.87	.983
50	.10	.18	.40	.64	.87
100	.05	.10	.22	.40	.63

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[1] These probabilities are less than 1, but for all practical purposes may be taken as unity.

(c) Chemical quality of water

Virtually no data are available on the chemical quality of these streams. Measurements of specific conductance in 1974 and 1975 indicate that the dissolved-solids content in flows in Spring Creek and South Fork Spring Creek ranges from about 1,200 mg/1 during periods of storm runoff to about 2,500 mg/1 during periods of low flow when most of the water probably originates from ground-water discharge. Similar results would be expected in Pearson Creek although no measurements have been made in that watershed. The dissolved-solids content in Deer Creek ranges from about 1,500 mg/1 during periods of storm runoff to about 5,000 mg/1 during periods of low flow. No measurements have been made on other streams in the East Decker area.

(d) Sediment

In the absence of runoff and sediment-yield data for ephemeral streams in the Decker area, estimates of sediment yield from the various watersheds were necessarily based on indirect methods. Estimates of gross erosion occurring in the watersheds of ephemeral streams traversing the proposed mine areas were made using the Universal Soil-loss Equation (U.S. Department of Agriculture, 1972b). Delivery ratios, based on curves reported by Roehl (1962) and adjusted for the respective relief ratios of the various watersheds, were used to convert estimated gross erosion to estimated sediment yields for specific streams.

In the absence of detailed data regarding the various environmental factors appraised by the soil-loss equation, average values, adjusted for slope conditions, were used. Assumptions and basic data used in the computation of sediment yields are detailed in Appendix D. Results of computations are summarized in table 18. It should be noted that the annual sediment yield reported in this table represents the long-term average. As most sediment movement in ephemeral streams occurs in response to high discharges generated by infrequent major storms, the reported average is probably somewhat higher than the actual sediment yield during most years.

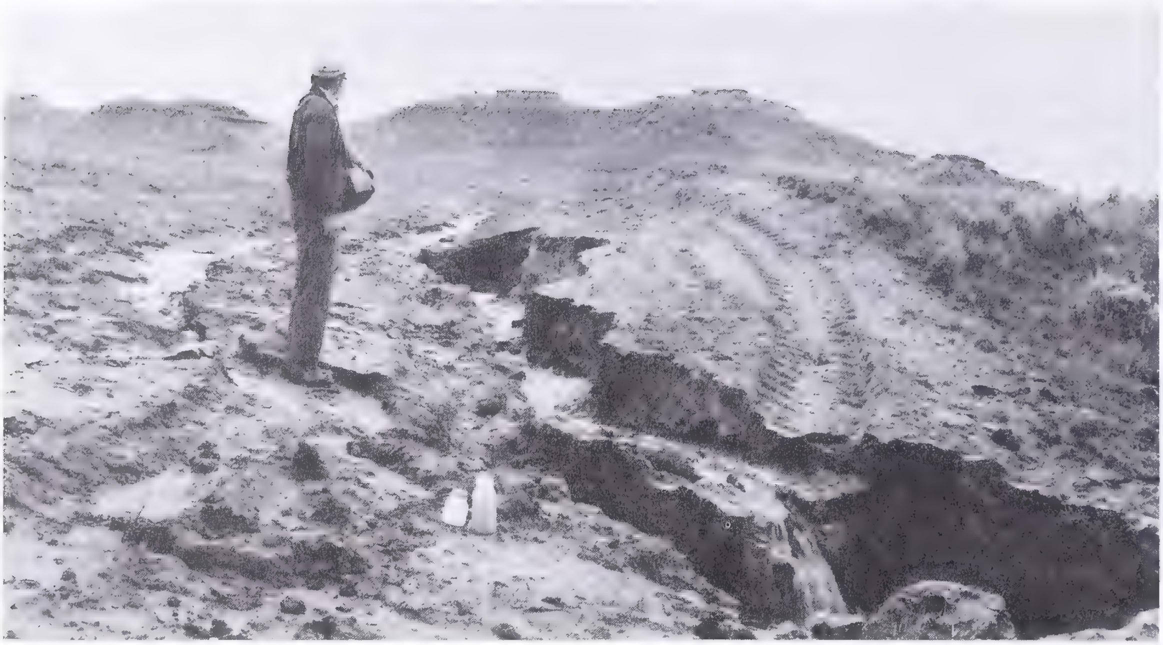
Table 18. -- Estimated long-term, average annual sediment yield from ephemeral streams in the Decker area

Name of stream	Drainage area (mi^2)	Average annual sediment yield			
		(tons/mi^2)[1/]	(acre-ft/mi^2)[1/]	(tons)	(acre-ft)[1/]
Deer Creek	53.3	430	0.28	23,000	14.8
Middle Creek	6.3	730	.48	4,600	3.0
Coal Creek	2.9	780	.51	2,300	1.5
Spring Creek	36.9	550	.36	20,000	13.3
Pearson Creek	8.5	580	.38	4,900	3.2
Pond Creek	6.1	680	.45	4,100	2.7
All streams	114	520	.34	59,000	38

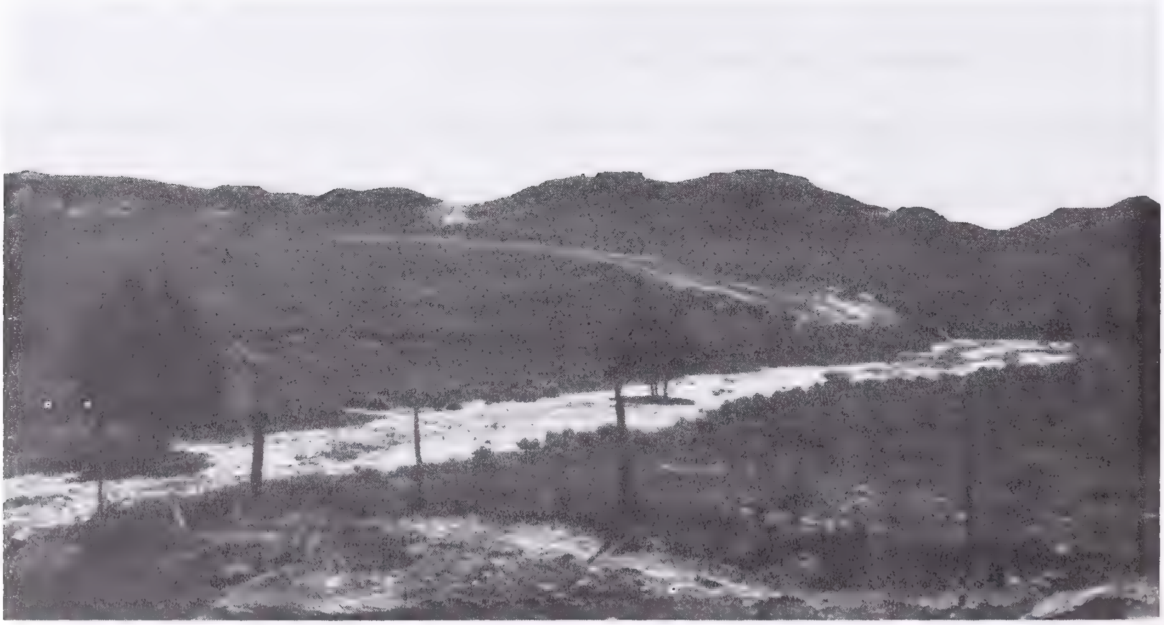
[1/] Sediment weight assumed to be 70 lbs/ft^3.

(e) Stream Diversions

Flow from the upper 2.2 square miles of the Pond Creek watershed enters a comparatively large retention reservoir in the NW¼ sec. 17, T. 9 S., R. 40 E. This structure was designed to contain all runoff during most years and to prevent flooding of the West Decker mine. Outflow from the reservoir is through a diversion ditch that drains generally northeastward about 2 miles into a tributary of Pearson Creek. An area of 0.6 square mile drains directly into this diversion ditch, which has a very limited flow capacity and is nowhere protected from erosion by a rock or clinker lining. Although no outflow has occurred from the impoundment on Pond Creek since its completion, flow has occurred frequently in the diversion ditch, causing locally servere bank and bed erosion (fig. 50 A). Most of the derived sediment has been deposited in the channel reach immediately downstream from the ditch mouth (fig. 50 B). On June 21, 1975, at 1415 hours, after a



A. Severe erosion occurring at the outlet of the diversion ditch, which drops abruptly into a tributary of Pearson Creek.



B. Deposition of sediment in the channel downstream from the mouth of the diversion ditch.

Figure 50.-Outlet of Pond Creek diversion ditch--an example of induced erosion and downstream aggradation.

low-intensity rainfall of about 1 inch, outflow from the ditch, estimated to be about 0.1 ft^3/s, was causing severe local scour (fig. 50 A). A sample showed a dissolved solids content of about 725 mg/l and a suspended sediment load of 8,360 mg/l. Sediment in transport was 51 percent sand, 38 percent silt, and 11 percent clay. Performance of this diversion to date attests to the erodibility of soils in the Decker area.

(f) Small impoundments

Data are not available to adequately appraise the effect on runoff of the many small impoundments that have been built in the above watersheds. U.S. Geological Survey 7½-minute quadrangle maps show the following existing impoundments in the respective watersheds in 1966.

Watershed	Number of impoundments	
	Estimated capacity less than 10 acre-feet	Estimated capacity more than 10 acre-feet
Deer Creek	36	10
Middle Creek	1	2
Coal Creek	3	0
Spring Creek	11	8
Pearson Creek	2	4
Pond Creek	2	1

In the period 1966 to 1975, some structures undoubtedly have failed; however an appreciable number of additional impoundments have been built during this period. The combined storage capacity of these structures probably exceeds 1,000 acre-feet. The net result is that these impoundments, which probably number more than 100, can be expected to significantly reduce runoff in those years when precipitation is not excessive in quantity or intensity. Very probably, however, these impoundments would have a comparatively small effect on major floods.

Most of the older impoundments, and especially those on South Fork Deer Creek, are largely filled with sediment and overflow frequently. Spillway erosion threatens their future utility. Nevertheless, ranchers report that these reservoirs are a dependable source of water for livestock and wildlife during most years. Measurements indicate that most impoundments contain water of better quality than that obtained from ground-water supplies. Dissolved solids content of the water commonly is less than 1,000 mg/1 and seldom exceeds 3,000 mg/1.

(g) Standing pools of water in channels

In the East Decker area open pools of water commonly occur throughout the summer during most years in the middle reaches of Deer Creek and locally in the lower reaches of Middle and Coal Creeks. Ground-water discharge to Deer Creek is sufficient in all but periods of extended drouth to maintain standing pools of water in scour holes in the reach adjacent to and extending about 3 miles downstream from the county road. These pools, which are fed by underflow moving downstream through the alluvium, are breeding grounds for mosquitoes and other insects and undoubtedly are an important element in the wildlife habitat. Measurements show that the dissolved solids content of the water generally exceeds 4,500 mg/1. The water, therefore, is marginal for use by livestock and most wildlife.

The absence of apparent saturation and prolonged flow in the lower reach of Deer Creek, extending about a mile upstream from the reservoir, is attributed to a greater thickness of alluvium in this reach.

In the North Extension area a seep area (table D-5, Appendix D) forms an open pool in the bottom of South Fork Spring Creek just upstream from its junction with the main stem of Spring Creek. With this exception, the lower reaches of Spring, South Fork Spring and Pearson Creeks are immediately underlain by unsaturated clinker materials. Channel depressions contain water only for short periods following storm runoff.

(4) Waters from past and present mining operations

(a) Tongue River mine lake

Excavation of coal at the Tongue River mine in the bottom of Spring Creek valley in sec. 33, T. 8 S., R. 40 E., has left a depression that has been partially filled by ground-water inflow. This small lake covers about 2 acres and has no inlet or outlet. The water has a dissolved solids content of about 1,500 mg/1 and a pH of 8.5.

(b) Water pumped from the West Decker mine

Inflow to the West Decker mine from surface runoff and from ground-water discharge is pumped into a water-treatment pond located near the NE¼NW¼ sec. 22, T. 9 S., R. 40 E. Overflow from this pond (0.2 - 0.6 ft^3/s) is discharged directly to the Tongue River Reservoir. The chemical quality of this mine effluent is described on p. 178.

B. The biological environment

1. Vegetation

a. Regional communities

The plant communities present in the Decker area are fairly representative of the Montana Mixed Prairie Association (Weaver and Albertson, 1956). The report area occupies a location near the ecotonal boundaries of the Palouse Prairie and the ponderosa pine--juniper savanna. Grassland associations exhibit a mixture of cool-season bunchgrass and low-growing shrubs typical of the Palouse Prairie flora, as well as short-tuft and sod-forming grasses and xerophytic sedges typical of the short-grass plains lying to the east and south of the Decker area.

Important factors in separating the Palouse Prairie flora from the short-grass plains flora are (1) the occurrence of certain tall clump-forming warm-season species (characteristic of the more mesic mid-grass prairies east of the Black Hills), (2) sod-forming grasses and (3) the typical needlegrass wheatgrass-big sagebrush flora of the Palouse Prairie region.

Two-thirds of the annual precipitation in the Decker area commonly occurs in the four-month period between March and June. The precipitation pattern is most beneficial to a large and vigorous complement of cool-season plants in the community. Warm-season plants in the Decker area bloom after the peak period of precipitation and are either restricted to areas of less ecological stress or exhibit smaller growth forms. Decker area vegetation is subject to, on the average, one year of drought out of every seven years.

Two forest zones occur in the Decker area: The first consists of ponderosa pine and juniper and is limited to local areas with topographic conditions conducive to advantageous moisture aquisition. The second is a broad-leaf deciduous forest, which is limited to riparian bottom lands.

The infrequent occurrence of forest zones in the Decker area, may be attributed to several factors: (1) Precipitation in the area is unsuitable both in amount and duration for extensive growth of forest-type vegetation;

(2) a seed source of more drought tolerant species apparently has not invaded the Decker area; (3) in the event that a seed source of a more drought tolerant species is present, an important environmental factor for maintenance of the species is absent (possibly substrate); and (4) frequent fires in the past have limited tree growth to only the most favorable sites.

The topography of the report area falls into four landform types. The first type can be classified as riparian bottom land. This type is composed primarily of alluvium deposited by ephemeral streams tributary to the Tongue River Reservoir. Riparian bottom land is commonly subirrigated or seasonally flooded and, therefore, supports a productive vegetative community.

The second major land-surface group is the nearly level to mildly rolling bench lands that represent the main erosional surface around the upper ends of the many intermittent drainages in the Tongue River system. Soils in this group tend to have few large aggregates and vary in texture from sandy loam to clay. The heaviest coverages of big sagebrush occur in the portions of this area that have deeper sandy loam soils. Soils with heavier clay fractions tend to have sodium-induced structure problems when subjected to periodic inundation and exhibit vegetation typical of poor-drainage areas.

Highly eroded hillsides and pinnacles with gravelly soils constitute the third landform present in the area. Because of runoff from the more level upland type and because of limited grazing owing to the steep hillsides, certain warm-season grasses, palatable browse shrubs, and plants of extreme susceptibility to grazing stress can maintain stands on this type of landform. The ponderosa pine-juniper savanna type occurring in the area is almost exclusively confined to the sidehills type of landforms where there is better moisture retention. Many of the soils in this landform are derived from clinker beds, and it is the resistance to erosion of this clinker material that gives the Tongue River drainage its distinctive red-peaked-hill appearance.

The fourth landform present in the area is the nearly level upland. The flatness of these benches tends to produce a thin soil mantle not heavily dissected by gullying. Areas of deeper soil on hill tops produce a cover of big sagebrush and grasses such as that of the Palouse Prairie type of grasslands. Because of low topographic relief, much of the area occupied by this type is severely overgrazed and produces the typical Palouse Prairie grazing response of sheet erosion, which reduces the soil thickness and creates erosion pavements that critically limit productivity.

b. Regional agricultural communities

Agricultural activity in the Tongue River valley of southeastern Montana and adjacent Wyoming may be classified into three general types according to the method of irrigation. The first type, customarily associated with benchlands and hilltops, is dryland, or nonirrigated cropland. Crops in this type are limited mainly to dryland haymeadows or drought-resistant small grains. Crested wheatgrass is commonly used for hay production because of its ability to resist drought and withstand winter and spring grazing pressure. Some Russian wildrye is also used in mixtures with dryland legumes such as sweetclover or trefoil to produce large amounts of single-cutting hay and winter pasturage. Winter wheat and winter barley are common choices for small grains on dryland areas because the majority of their vegetative growth occurs during the peak-precipitation season.

It is important to note that dryland acreage in the Tongue River valley encompassing the Decker area varies as a function of economics. When it becomes feasible, large portions of the arable surface in the valley are brought into production for short periods and removed again as economic conditions dictate.

The second type of agriculture associated with the Tongue River valley encompassing the Decker area is the variety supported by mechanical irrigation methods. Because of the large capital investment involved, use of mechanical irrigation systems has been confined primarily to large farms, except for some small-scale portable systems. Center-pivot sprinklers are the most prominent type of mechanical irrigation system used in this portion of the Tongue River valley. Other systems consist mainly of pumps and manually-distributed sprinkler pipe, although at least one system exists in the area that pumps water from the Tongue River reservoir into a series of flood ditches lying above the level of the reservoir.

Major crops produced on land irrigated by mechanical methods are alfalfa and mixed-grass hay. Common grass mixtures include timothy, orchard grass, smooth brome, Kentucky bluegrass, intermediate wheatgrass, and big bluegrass. Common legumes in hay production include alfalfa, sainfoin, sweetclover, and trefoil.

Low-lying areas along the flood plain of the Tongue River and its major tributaries are frequently irrigated by flood-ditch systems. Because of the comparatively low capital investment required for equipment and land leveling, this is the most common type of irrigated agriculture in the Tongue River drainage.

Hay production has been possible locally in those areas where run-in moisture is spread by a system of dikes and ditches or where subirrigation occurs in the bottoms of those stream valleys that have shallow water tables. Excellent results have been obtained by these methods in the middle and upper reaches of Deer Creek valley in the East Decker area. Conversely, water spreaders in the lower reach of Pearson Creek valley in the North Extension area have not been maintained and are now largely defunct.

Irrigated hay fields in the broad lower reach of Spring Creek valley in the North Extension area are highly productive. Water is currently being pumped from the Tongue River Reservoir to irrigate about 437 acres. Crops, which include small grains and alfalfa hay grown in a rotation system, are used as supplemental feed for livestock.

Flood-irrigated areas produce the most significant portion of agricultural products in the Tongue River valley encompassing the Decker area. Irrigated haymeadows seeded to alfalfa, alsike and sweetclover, sainfoin, trefoil, and various grasses that do well under irrigation are widely used and produce a majority of the winter livestock feed used in ranching operations in the area. A significant amount of silage corn used for feeding livestock is produced in several operations upstream from the Tongue River Reservoir. Oats, barley and wheat are also grown.

Low annual precipitation and a 150-day frost-free growing season severely limit the potential of the upper reaches of the Tongue River valley for extensive agricultural activity other than grazing and forage production.

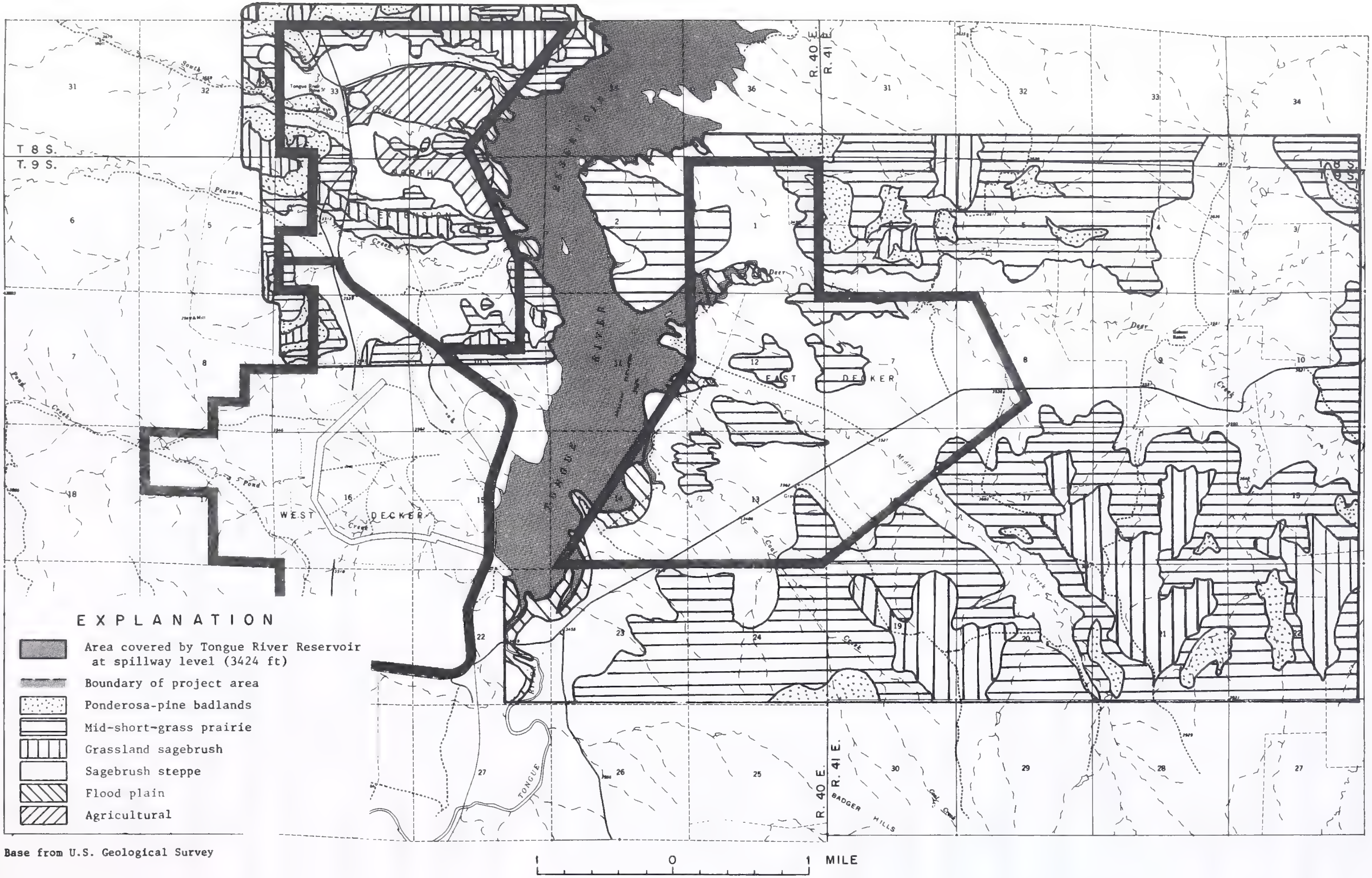
c. Vegetation in the Decker area

The major discernable factor involved in limiting the distribution of each plant-community type present in the East Decker and North Extension areas appears to be topographic relief and its inherent effect on soil characteristics and moisture availability. Differences in elevation (765 feet maximum) appear to have a minimal effect on the vegetative ecological relationships.

For the purposes of this impact statement, five separate, but ecologically interrelated, natural vegetation types or communities can be recognized in the Decker area. Vegetation types follow those proposed by Kuchler (1964).

The distribution of the five vegetative types within the two mining areas is shown on figure 51. Agricultural areas, a sixth vegetative type, are also shown on figure 51. The Latin name and origin for each of the vegetative species found within the proposed mine areas are listed in table E-1 (Appendix E).

Appendix E gives the methodology of vegetation sampling used in analyzing each of the vegetation types followed by the percent frequency, total cover, and percent total cover for each of the major species within each of the five types. Production data for each of the five vegetation types are given in tables E-1 and E-13, Appendix E.



Base from U.S. Geological Survey

Figure 51.—Vegetation types in the East Decker and North Extension areas.

(1) Sagebrush-steppe community type

This community occupies the largest land surface within the proposed mining area and is primarily found on gently rolling benches of low topographic relief. Customarily, the sagebrush-steppe community type may be associated with silty loam, clay loam, and clay soil units throughout this region of the Northern Great Plains. Local occurrence of varying soil textures has a visible effect on species dominance and species composition within the community type. Areas of more heavily textured soil tend to be dominated by big sagebrush with western wheatgrass and needle-and-thread grass sharing a position of codominance. Understory species associated with this community type vary with the amount of plant-available sodium, a function of soil drainage. An understory of blue grama, alkali tumblegrass, Japanese brome, and shrubs such as rubber rabbitbrush and silver saltbush are found associated with this soil and community type throughout the area.

Soils of lighter loamier texture produce a more open grassland aspect owing to a lessened dominance by big sagebrush. Replacing the canopy of big sagebrush is a bunchgrass overstory, and a blue grama and threadleaf sedge understory. The bunchgrass overstory commonly consists of western wheatgrass, Montana wheatgrass, needle-and-thread grass, and green needlegrass.

Also occurring commonly on sites in this type are cheatgrass brome, plains prickly pear, prairie junegrass, sandberg bluegrass, winter fat, plains bluegrass, scarlet globemallow, and Indian ricegrass. Sand dropseed occurs on the sandier sites.

The sagebrush-steppe type, because it typically occurs in low topographic relief, has been subjected to extensive grazing pressure by livestock operations in the Decker area. Long-standing grazing abuses have reduced the livestock carring capacities and the carrying capacity for some wildlife species to approximately 50 percent of what is considered normal for areas of this community type elsewhere in the Northern Great Plains. Palatable plants that tend to decrease in both production and abundance with overgrazing are prairie junegrass, plains bluegrass, sandberg bluegrass, western wheatgrass, Montana wheatgrass, and Indian ricegrass. Needle-and-thread, green needlegrass, big sagebrush, rubber rabbitbrush, and plains prickly pear, species that are less palatable to livestock, tend to increase in production and abundance with increasing grazing pressure. Species in the sagebrush-steppe type that are not native or not present under normal range maintenance include Japanese brome, cheatgrass brome, and yellow sweet-clover. Yellow sweetclover was originally planted in conjunction with haymeadow improvement efforts in the Decker area and has since occupied the position of an invader in this community type.

(2) Grassland-sagebrush community type

Floristically, the grassland-sagebrush community type bears a close resemblance to the Palouse Prairie type as delineated by Weaver (Weaver and Albertson 1956). Characteristically, the type occurs on well drained loamy soils of various origins that have little or no sodium. The community is fairly homogeneous with sagebrush, bluebunch wheatgrass, and needle-and-thread grass dominating the canopy coverage. Threadleaf sedge is the major, naturally occurring species in the understory. Many species of cool-season bunchgrasses appear with some frequency in this community type, but none of the various warm-season grasses plays a large part in community dynamics, and only blue grama occurs with a predictable frequency. Cool-season species commonly occurring in conjunction with this type are prairie junegrass, Montana wheatgrass, western wheatgrass, slender wheatgrass, Japanese brome, and cheatgrass brome.

This community type exhibits the greatest diversity of broad-leafed species to be found in the Decker area. Common shrubs in the area are big sagebrush, rubber rabbitbrush, leadplant, broom snakeweed, Rocky Mountain beeplant, and winterfat. Commonly, leguminous forbs attain peak frequency and abundance in the spring, while the asters exhibit warm-season phenology. Such plants as Hoods phlox, Douglas wild buckwheat, wooly milkvech, Lambert locoweed, and Nuttall deathcamus produce a major portion of early spring growth, while hairy goldenaster, western yarrow, western goldenrod, and prince's plume exhibit growth well into the fall and last beyond the first killing frosts.

Because of the relatively uniform topography and marginal soil thickness, the grassland-sagebrush community type has been subjected to severe grazing pressures for many years. This type follows patterns of succession and response to stress that are characteristic of the Palouse Prairie flora (Weaver and Albertson, 1956). On thinner, more vulnerable soils, a reduction in such palatable forage species as bluebunch wheatgrass, Montana wheatgrass, and prairie junegrass produces increases in broom snakeweed, fringed sagewort, dotted gayfeather, hairy goldenaster, and other less-palatable livestock-forage plants. On deep, loamy soils increased grazing pressure shows a corresponding increase in big sagebrush, needle-and-thread grass, and plains prickly pear. Under sustained extreme use, especially during early spring, big sagebrush and needle-and-thread grass are severely reduced, and plants such as Japanese brome, cheatgrass brome, prince's plume, and pinate tansymustard invade, producing little edible forage.

The grassland-sagebrush community type occupies hilltops and well-drained benches in the Decker area and is, for the most part, not directly involved in the disturbance area of the proposed operations.

(3) Mid-short-grass prairie community type

The third vegetative type present in the area is the mid-short-grass prairie. This community is primarily limited to steep sidehills and the well-drained loamy and coarse-textured soils associated with the erosional surfaces. Two community subtypes exist in the area and are delineated on the basis of soil depth and texture.

Convex contoured slopes tend to lose fine-textured soil materials as the result of surface erosion and thus exhibit a high percentage of large aggregate materials. The association of plants that inhabit this subtype is a mixture of warm-season bunchgrasses such as little bluestem, red three-awn, and under ideal grazing conditions, sideoats grama, blue grama, and threadleaf sedge. Many small sulfrutescent shrubs and low-growing forbs, such as Porter Pleabane, Hood's phlox, and fringed sagewort, form clumps and pedestals in the widely spaced canopy. Occurrences of low shrubs, such as skunkbush sumac and western snowberry, tend to be associated with outcrops of clinker and sandstone ledges throughout the Decker area.

The other plant association connected with this community type occurs on sandy-loam or silt-loam soils in such concave-slope configurations as the heads of ephemeral stream channels. This association is dominated by dense sods of prairie sand reedgrass, a rank-growing rhizomatous perennial that produces large amounts of vegetative material. This plant's soil-binding abilities significantly retard mass movement in the loose-textured soil on which it occurs. Western ragweed, sand sagebrush, silver saltbush, curlycup gumweed, Louisiana sagewort, and Fendler sunflower commonly occupy spaces among the prairie sandreed sods.

Because of the steeper topography upon which this community type is found, grazing has not exerted the amount of influence on community structure that it has in other community types in the Decker area. Under grazing pressure, palatable species such as sideoats grama tend to be depleted or reduced in vigor. Little bluestem and blue grama resist grazing damage somewhat better, but also exhibit reduced vigor and production under extreme pressure. Because of their low growth form, Hood's phlox, threadleaf sedge, Porter Pleabane, Gardner saltbush, and fringed sagewort escape utilization and tend to increase. Prairie sand reedgrass, because of its rank growth, is not palatable except in the early spring when it is often bypassed for more desirable plants and thus exhibits no grazing related behavior. Louisiana sagewort, sand sagebrush, broom snakeweed, curlycup gumweed, Fendler sunflower, and red three-awn are offensive or nonpalatable to grazing animals, and thus escape grazing pressure and tend to increase. Bluebunch wheatgrass occurs infrequently on some sites and predictably decreases under grazing stress. Japanese brome and cheatgrass brome invade all sites where grazing is a factor.

(4) Ponderosa-pine badlands community type

The ponderosa-pine badlands type, although not recongized by Kuchler (1964), exists throughout the Northern Great Plains on uplands having rocky soils. Some stands of ponderosa pine and Rocky Mountain juniper are dense enough to qualify as forests, but for the most part, the major occurrence of the type is limited to widely spaced savanna-like canopies or individual trees in rough country in locations having suitable soil-moisture and topoedaphic conditions. Tree size canopy densities and growth forms for both species vary widely within the Decker area. Rare occurrences of Utah juniper are also present on some of the better sites within this community type, but the growth form of these individuals is that of a low shrub.

Understory species within the ponderosa-pine badland community type varies according to both substrate and grazing intensity. Nonsaline substrates that have been mildly grazed exhibit an association of grasses similar to that of the mid-short-grass prairie community, dominated by little bluestem, sideoats grama, red three-awn, and bluebunch wheatgrass. Severely used areas, or areas with substrates derived from clinker or shale, tend to produce an understory dominated by annual bromes, various thistles, and curlycup gumweed.

Certain sites possess a well-developed browse-shrub community consisting of skunkbush sumac, western snowberry, Wood's wildrose, western chokecherry, red wildplum, and prickly currant. These species tend to concentrate in dense thickets in areas of deeper soil along ephemeral stream channels.

Because of the extreme variability of the understory plant associations for the Ponderosa-pine badland community, attempts to determine grazing response for understory species within their community are limited to specific areas of occurrence. Generally, bluebunch wheatgrass, sideoats grama, and little bluestem tend to decrease under grazing pressure. Sandberg bluegrass is present on one very steep, isolated site, suggesting that it may have been a member of the climax plant association in the years prior to extensive livestock usage.

(5) Riparian community type

The flood-plain or riparian-grassland community type occurs primarily along the lower flood plain of the Tongue River, on the annually flooded shores of the reservoir, and along the flood plain of the Deer Creek drainage. These areas produce heavily silted mudflats that are covered in the late summer and fall with broad-leafed flora dominated by curly dock, broad-leafed plantain, and cockleburr. All of these species provide some livestock feed late in the year because of their delayed phenology and the plentiful water which is locally available. This vegetation subgroup can sustain usages far beyond the capabilities of any other vegetation types within the Decker area.

The flood plain of Deer Creek, Coal Creek, and the nontimbered part of the flood plain of the Tongue River comprise the most productive grassland type in the Decker area. This type is classified as a riparian-shrub grassland. Very high canopy coverages of such species as western wheatgrass, streambank wheatgrass, mammoth wildrye, creeping wildrye, foxtail barley, marsh arrowgrass, silver sagebrush, and Baltic wirerush are very common on many of the subirrigated bottomlands in the area. Many of these areas have been mowed and improved for hay cropping. Common meadow-improvement practices are interseeding with species such as smooth brome, common canarygrass, Kentucky bluegrass, orchardgrass, and yellow sweetclover. These subirrigated meadows can sustain greater grazing pressures or cropping use than the surrounding area and similarily are not subject to the same degree of accelerated erosion under a more intense removal of the vegetative overstory.

Adjacent to the river or standing waters of the reservoir, just above the high water level, the ground surface is dominated by a western deciduous forest type referred to as flood-plain timber. The canopy of these forests consists mainly of plains poplar, lanceleaf poplar, boxelder maple, and peachleaf willow. In most areas a dense second canopy of coyote willow extends from the bottom of the poplar canopy to the ground. Open spots in the canopy, such as the banks of flowing streams and edges of pooled water, support dense growths of blackroot sedge, American bulrush, and prairie cordgrass. Large clumps of mammoth wildrye and thickspike wheatgrass occupy open spots in the canopy.

The area of riparian (flood-plain) vegetation at the mouth of Deer Creek represents the most extensive riparian community bordering the east side of the Tongue River Reservoir to survive flooding (fig. 51). This riparian community borders a large expanse of arid uplands and, owing to its unique nature, serves as a focal point for much biological activity.

Vegetation at the mouth of Deer Creek is undergoing great change, primarily as a result of the establishment of the reservoir. Numerous poplars have died and fallen, resulting in a great amount of biomass which covers large sections of the stream channel and adjacent mud-flat areas. Indications are that this area formerly contained a dense poplar flood-plain forest composed of a fairly even-aged stand of trees perhaps averaging 30 to 40 years in age. Reservoir high water has destroyed this stand, except on perimeter areas that remain above high-water levels. The higher water table has resulted in a transition of cottonwood habitat. New stands ranging in age from 10 to 20 years have invaded areas 10 to 15 feet higher than the previous stands.

Understory vegetation on the mud flats and channel margins responds to the annual cycle of flooding. This area, consisting of alluvium deposited by Deer Creek, supports dense stands of curly dock with various grass and sedge species as well as other forbs. This moist site offers late-season forage owing to the abundance of moisture.

The new flood-plain forest communities in lower Deer Creek valley are dense and promise to equal or exceed the tree volume which previously existed. These young stands have invaded lower areas, particularly those adjacent to the stream channel as one moves upstream. The upstream invasion has overlapped with older poplars that survived establishment of the reservoir. Density and distribution of these younger stands are sufficient to stabilize the channel in the lower portion of Deer Creek.

Within the next decade, the character of lower Deer Creek valley should evolve into a continuous, dense poplar stand, unless the environment is modified by man. Closure of the forest cover as the stand grows denser would tend to change the understory vegetation such that shade-tolerant species would probably invade the area. Such an environmental shift would serve to magnify the unique character of this area as it extends eastward from the reservoir into the arid, shadeless, prairie upland.

Upstream from the mouth of Deer Creek where the stream channel is better defined, willows are intermixed with the young poplar. These willows show heavy grazing use by livestock and wildlife. The adjacent flood plain contains a dense grass cover, primarily western wheatgrass, which has been heavily grazed by cattle. In spite of heavy use, the ground cover is still very dense. Throughout this area, the heavy annual deposition of poplar and willow leaves serves as a mulch that helps to retain soil moisture and fertility.

At the uppermost end of the young poplar habitat, the flood plain forest evolves into an open, park-like stand of massive, aged poplars. These trees appear to be well in excess of 100 years old. The fertile soils in this reach of the flood plain support very dense and productive grass communities. This valley reach is more dependent on Deer Creek to supply subsurface water than on reservoir surface fluctuations. The slightly drier condition of the soils is indicated by the increased diversity of grass species, most of which can be found in the upland prairie areas. A difference exists in that the growth achieved by the grass species growing in the Deer Creek valley is greater, and hence, this area is capable of sustaining more intensive grazing than adjacent areas.

The Deer Creek vegetation community undergoes a transition as it extends eastward up the Deer Creek flood plain. Among the older stand of poplars, wheatgrasses, marsh arrowgrass, and Baltic wirerush are common.

With increasing distance upstream, silver sagebrush assumes greater dominance. This transition appears to indicate an increasing depth to the water table with distance upstream. However, at no point in this transitional area does the flood plain vegetation resemble the composition of the more sparse vegetation on the adjacent high benches.

2. Wildlife

a. Mammals and birds

A preliminary wildlife survey of the West Decker area, including a list of possible wildlife inhabitants, was completed in the late summer and fall of 1973 by Montana State University (Montana Agricultural Experiment Station, 1975). Later wildlife studies in the Decker area include: Decker Coal Co.'s Wildlife Survey Report (1975) and the Montana Department of Fish and Game's, Birney-Decker Wildlife Survey (Knapp, 1975a, 1975b).

Baseline information on seasonal distribution, habitat use, and population characteristics for the proposed Decker mine areas is found in environmental assessments prepared by (VTN Colorado, 1975a, 1975b) and in the Montana Department of Natural Resources Preliminary Environmental Review (1976).[1/] In addition to these assessments, the Montana Fish and Game Department gathered information for wildlife species in the vicinity of the proposed Decker mines during the summer of 1975. Wildlife investigational methods used in Decker area studies are described in Appendix F.

Available wildlife data were analyzed by the Montana Fish and Game Department on a seasonal basis wherever appropriate -- winter, January

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[1/] The population characteristics discussed in this section include reproductive success, (i.e., fawn/doe ratios); sex characterisitic, (i.e., no. males, no. females); population size; and population trends, (i.e., increasing, decreasing).

through March, spring, April through June, summer, July through September, and fall, October through December. Data collected in 1974 were, for the most part, limited. To compensate for this deficiency, seasonal data for 1974 and 1975 were in most instances combined. The following text was prepared for the Department of State Lands by the Montana Department of Fish and Game unless otherwise referenced.

(1) Mule deer

(a) Distribution

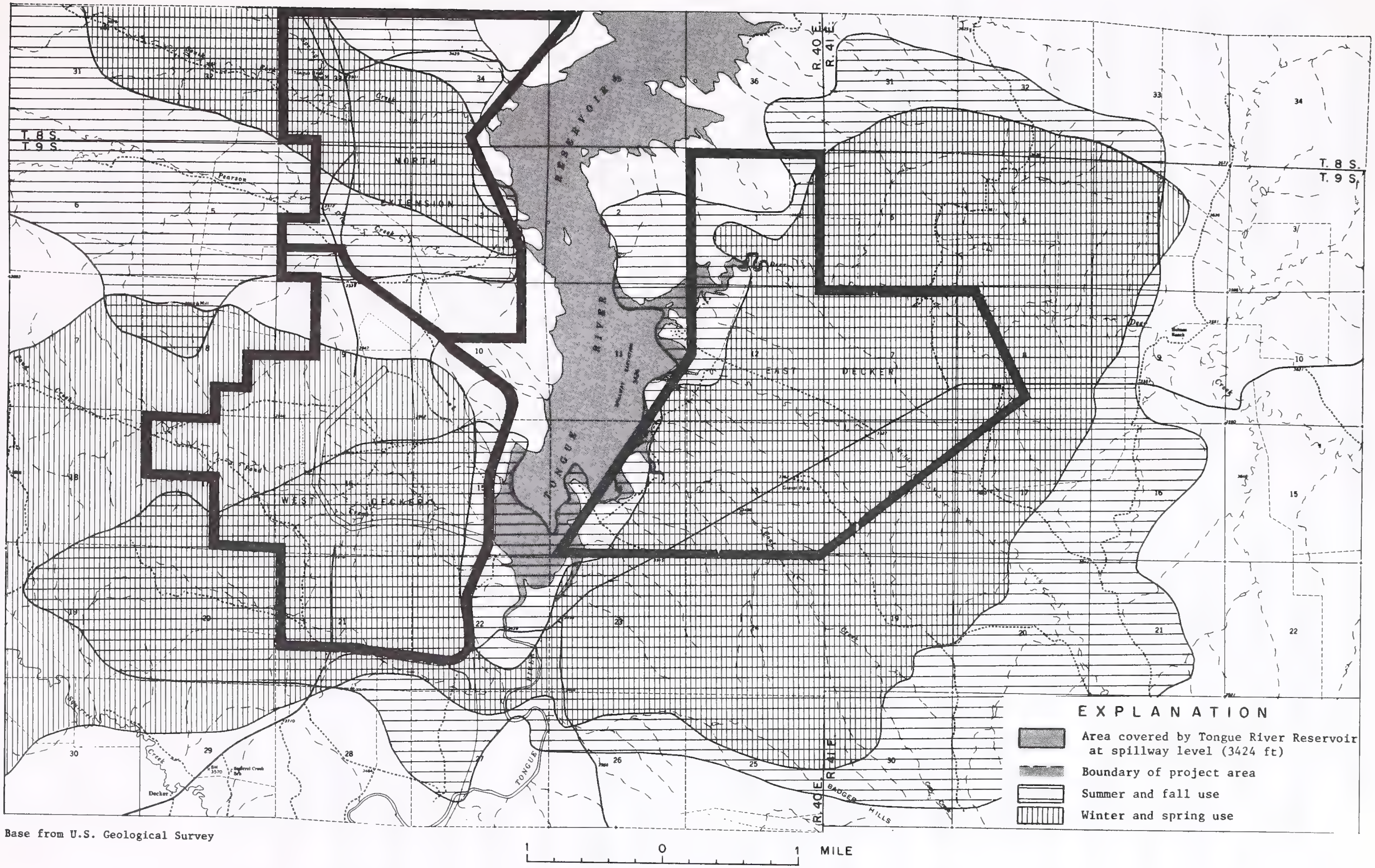
Mule deer are found throughout the Decker area (fig. 52). In the proposed East Decker area, the major portion of the mule deer range is used year round as evidenced by the close similarity in winter-spring and summer-fall ranges (fig. 52).

On the west side of the reservoir, mule deer tend to concentrate in the vicinity of the West Decker mine with a small herd of mule deer (up to 23) actually living within the mine boundaries. Summer-fall distribution in the West Decker mine area is more restricted as the deer probably concentrate in the willow and cottonwood patches bordering the upper end of the reservoir and along the Tongue River where it enters the reservoir. This is also an area utilized by does and their fawns for bedding.

The North Extension area is primarily a summer-fall range. It can only be speculated where these deer go during the winter. Knapp (1975a) found large concentrations of mule deer further up Pearson and Spring Creeks, indicating that perhaps these may be areas to which such deer migrate.

(b) Use of habitat types

During winter and spring, mule deer are concentrated in the sagebrush-steppe communities (60 percent and 67 percent, respectively) (table F-1,



Base from U.S. Geological Survey

Figure 52.– Seasonal distribution of mule deer in the Decker area in 1974 and 1975.

Appendix F). During the winter, the grassland-sagebrush, ponderosa-pine badlands, and reclaimed areas (14 percent, 14 percent, and 10 percent, respectively) comprise most of the remaining use. During the spring, light use was recorded for the mid-short-grass prairie, riparian, and agricultural communities (table F-1, Appendix F).

In the summer, mule deer use of habitat types was much more diversified with no one type predominating (table F-1, Appendix F). The riparian type received 34 percent of the observed use and the sagebrush steppe 26 percent. The remaining four types received from 14 percent use (ponderosa-pine badlands) to 1 percent use (reclamation area).

Although comparatively little data were gathered during the fall, mule deer were observed, in declining order of frequency, in the following habitat types: Sagebrush-steppe, agricultural, reclamation, and grassland-sagebrush.

(c) Population characteristics

A total of 1,693 mule deer sightings were made in 21 months of observation. Of these 722 were classified as to sex and age group, with the majority of such determinations being made during the summer. Using the summer figure, a fawn/100 doe ratio of 19 and a male/100 female ratio of 20 were calculated. A fawn/100 doe ratio of 19 indicates very low reproduction for mule deer in the Decker area when compared to statewide figures. Knapp (1975a) calculated a fawn/100 doe ratio of 52 for the Decker vicinity, indicating perhaps that a sharp decline in reproduction may have occurred recently or possibly that studies subsequent to Knapp's experienced difficulty in observing fawns.

(2) White-tailed deer

(a) Distribution and use of habitat types

A small number of white-tailed deer (15-20) are found around the southern end of the Tongue River Reservoir and along the Tongue River near its confluence with the reservoir (fig. 53) (VTN Colorado, 1975a). These white-tails remain largely in this area year round, occasionally feeding in the adjacent alfalfa field and on haystacks.

(b) Population characteristics

During the study period, a total of 121 animals were sighted in 15 observations. White-tail reproductive status in this area is somewhat better than that of mule deer with a fawn/100 doe ratio of 50. The buck/100 doe ratio is also 50. VTN estimated the Decker area white-tail population to be 14-18. (VTN Colorado, 1975a)

(3) Pronghorn antelope

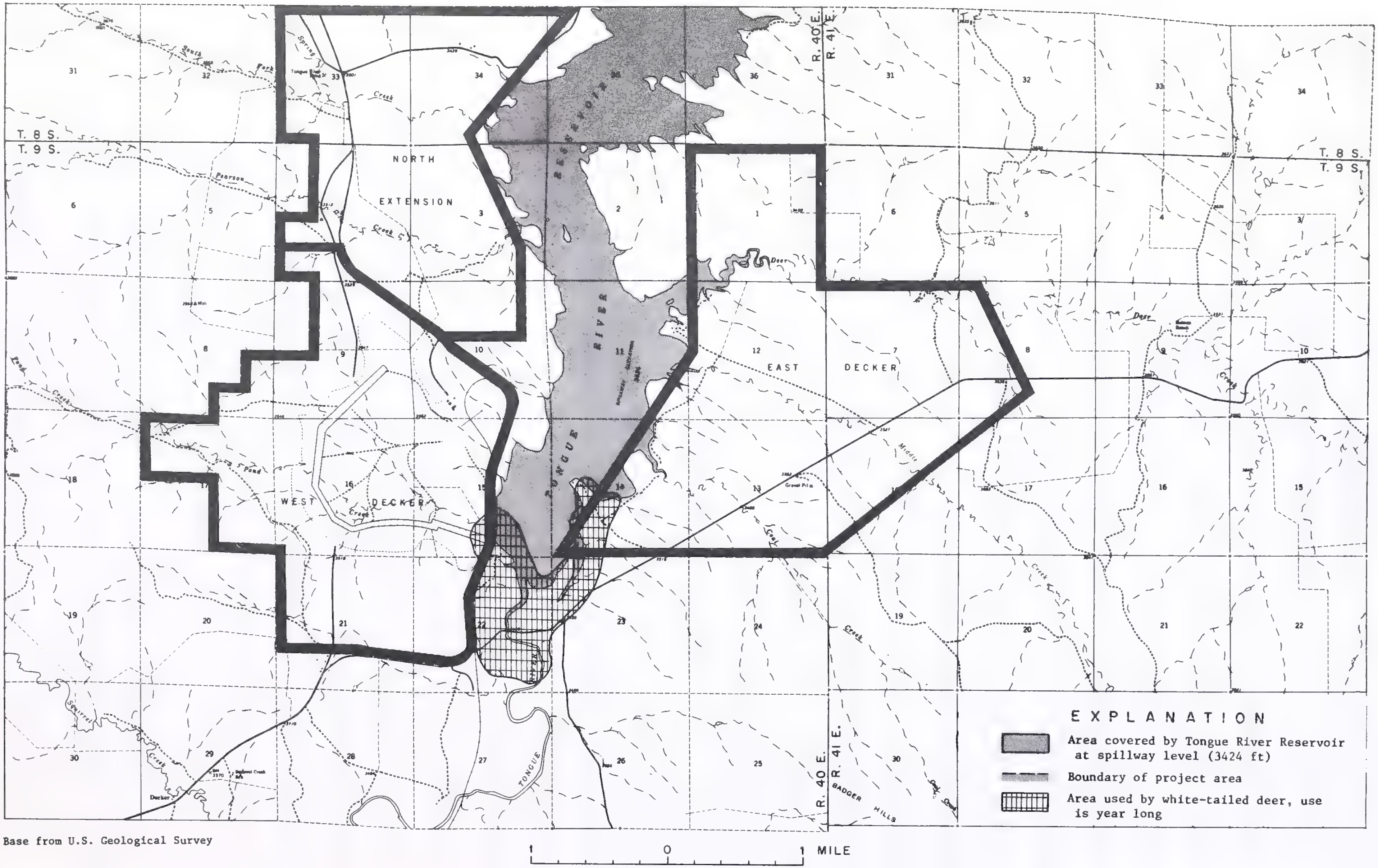
(a) Distribution

Pronghorns are commonly observed on the proposed East Decker mine site. During the summer and fall, they range within and for 2-3 miles around the proposed site (fig. 54). During the winter and spring, these animals use a smaller area within their summer-fall range.

On the west side of the reservoir, antelope range across and to the north of the proposed North Extension mine site during the summer and fall. As in the area east of the reservoir, winter and spring use is within a smaller area of the summer-fall range (fig. 54).

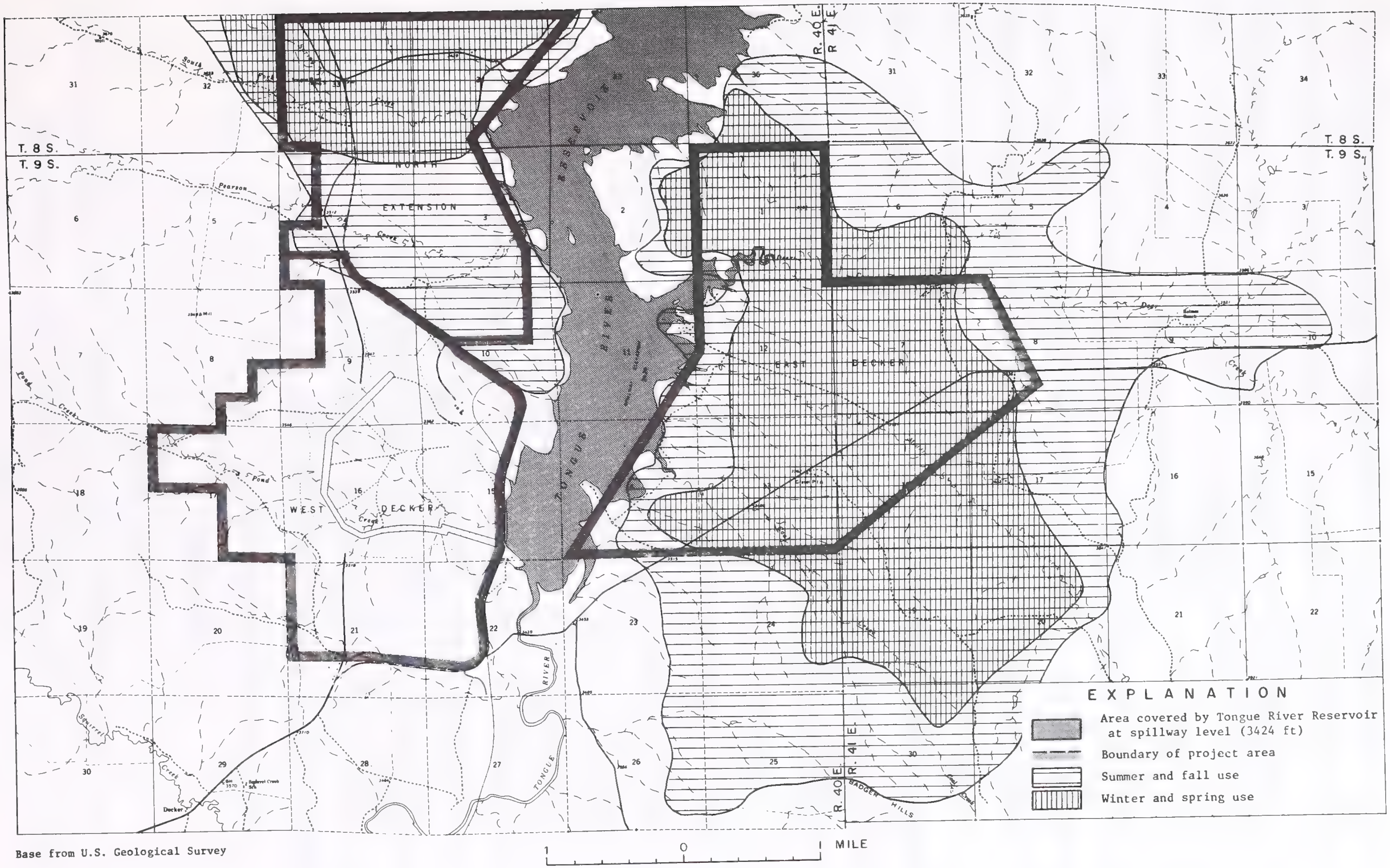
(b) Use of habitat types

During the winter and spring, the majority of observations were in the sagebrush steppe (65 percent and 52 percent, respectively) (table F-1,



Base from U.S. Geological Survey

Figure 53. – Distribution of white-tailed deer in the Decker area in 1974 and 1975.



Base from U.S. Geological Survey

Figure 54.—Seasonal distribution of antelope in the Decker area in 1974 and 1975.

Appendix F). During the winter, significant use also occurred on the mid-short-grass prairie (18 percent) and the grassland-sagebrush type (15 percent). The mid-short-grass prairie and grassland-sagebrush types were also important in the spring (12 percent use each), as was the ponderosa-pine badlands (14 percent use). During the summer months, pronghorns utilized a greater number of habitat types. Use was still highest in the sagebrush-steppe type (31 percent), but three other types-- the grassland-sagebrush, mid-short-grass prairie, and agricultural types all had 20 percent observed use.

Female antelope with fawns spend a large portion of their time in sub-irrigated bottomlands, such as lower Deer Creek valley, owing to the palatable, highly proteinaceous forage found in such areas (personal communication between Dick Juntunen, Chief, Coal Bureau, Department of State Lands and Dr. B. O'Gara, Asst. Leader, Montana Cooperative Wildlife Research Unit, February 1976 and between Dick Juntunen and D. Pyra, Montana Fish and Game Department, February 1976).

(c) Population characteristics

During the study period, a total of 2,483 antelope were counted in 310 observations. Of this number 1,618 were classified as to sex and age group. The greatest proportion of these animals were classified during the summer when fawns were easily identified. For this period there was a fawn/100 female ratio of 50 and a male/100 female ratio of 32. The fawn per doe ratio of 50 indicates adequate reproduction.

(4) Sage grouse

(a) Distribution

Sage grouse were observed at regular intervals within the Decker study area. An important strutting ground is located within and adjacent to the southeastern boundary of the proposed East Decker mine site in the SW¼, sec. 7, T. 9 S., R. 40 E. (fig. 55). Female sage grouse with young were also observed on several occasions along the west shore of the reservoir adjacent to the proposed North Extension mine.

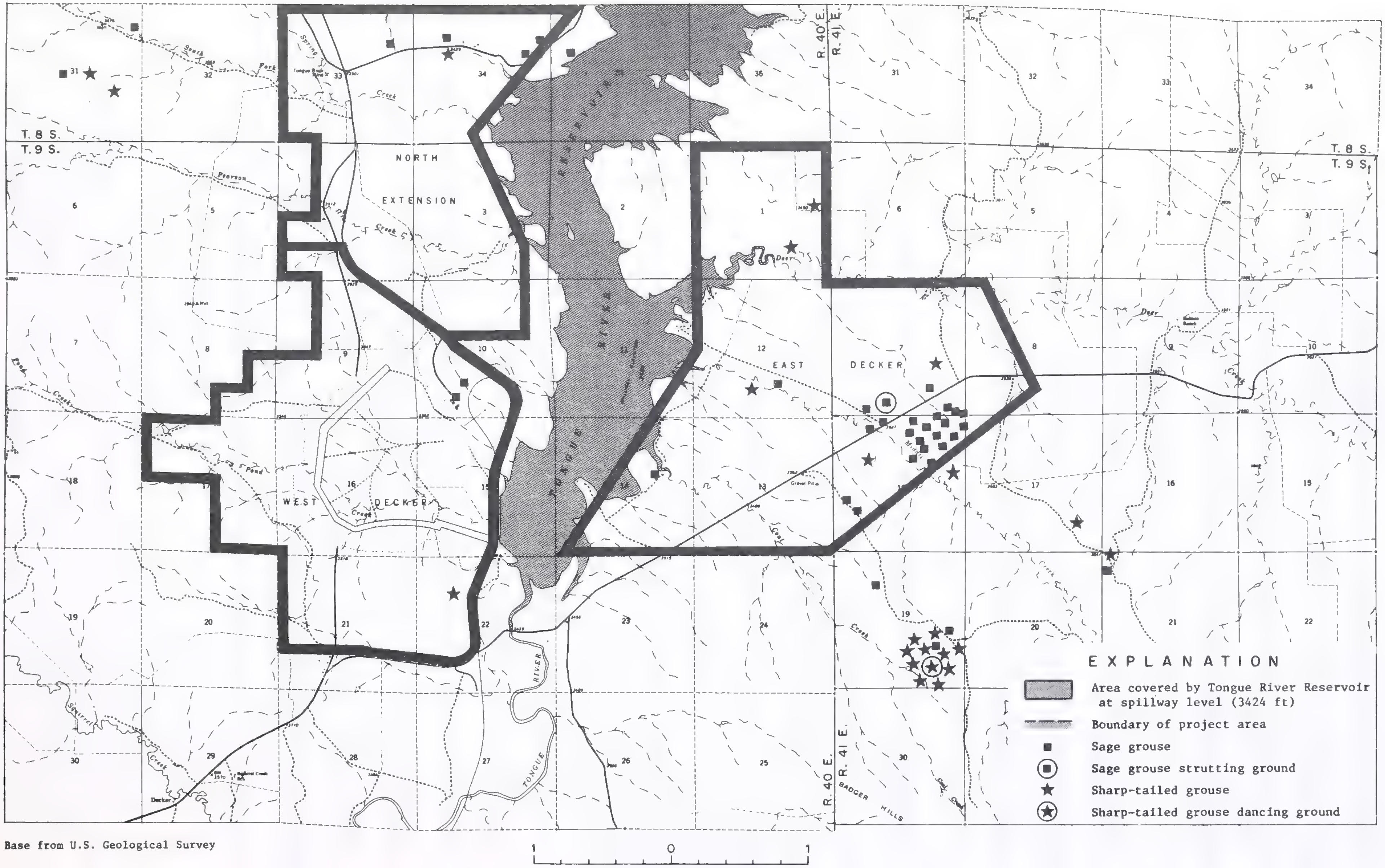
(b) Use of habitat types

During the winter and spring, sage grouse were found in the sagebrush-steppe communities (80 percent and 79 percent, respectively) and in the grassland-sagebrush community (20 percent and 21 percent respectively) (table F-3, Appendix F). During the summer, habitat use is more diversified. About half of the summer observations (48 percent) were in the sagebrush steppe, while the grassland-sagebrush and mid-short-grass prairie received 17 percent use; roadsides received 13 percent use, and agricultural fields received 5 percent. No sightings were made in the fall.

(c) Population characteristics

The strutting ground adjacent to the proposed East Decker mine showed various levels of activity by courting males during the spring period (table 19). In 1974 a high of 23 strutting males was observed on April 2. In 1975 a high of 19 males was observed on April 18, 19, and 20.

In late August 1974, one brood of sage grouse was observed within the Decker study area. This sighting included four females and six young. In 1975, ten broods were observed within the study areas and a total of 13 females and 63 young were counted for the year. The sightings for 1975 indicate that an average of 5 young were produced per female.



Base from U.S. Geological Survey

Figure 55.—Sage grouse and sharp-tailed grouse sightings in the Decker area in 1974 and 1975.

Table 19.--Sage grouse strutting-ground counts for spring 1974 and 1975

Number of males	Date	Location
7	3-15-74	SW¼ sec. 7, T. 9 S., R. 41 E.
2	3-20-74	SW¼ sec. 7, T. 9 S., R. 41 E.
17	3-21-74	SW¼ sec. 7, T. 9 S., R. 41 E.
23	4-02-74	SW¼ sec. 7, T. 9 S., R. 41 E.
9	4-17-75	SW¼ sec. 7, T. 9 S., R. 41 E.
19	4-18-75	SW¼ sec. 7, T. 9 S., R. 41 E.
19	4-19-75	SW¼ sec. 7, T. 9 S., R. 41 E.
19	4-20-75	SW¼ sec. 7, T. 9 S., R. 41 E.
10	4-22-75	SW¼ sec. 7, T. 9 S., R. 41 E.
18	4-24-75	SW¼ sec. 7, T. 9 S., R. 41 E.
13	4-30-75	SW¼ sec. 7, T. 9 S., R. 41 E.
17	5-02-75	SW¼ sec. 7, T. 9 S., R. 41 E.
17	5-07-75	SW¼ sec. 7, T. 9 S., R. 41 E.
6	5-10-75	SW¼ sec. 7, T. 9 S., R. 41 E.

(5) Sharp-tailed grouse

(a) Distribution

Sharptails were seen sporadically in the study area with most observations being made in the vicinity of a dancing ground or "lek" located approximately one mile south of the proposed East Decker mine site in the SE¼, sec. 19, T. 9 S., R. 41 E. (fig. 55). This sharptail dancing ground is the only one that has been located by the Department of Fish and Game in their Decker area studies. Today the distribution of sharptails is confined to prairie uplands where excessive grazing and farming have not completely altered the native vegetation (VTN Colorado, 1975a, and Montana Fish and Game Department, 1971). The area of the two proposed Decker mines, for the most part, has been severely overgrazed and, therefore, contains very little sharptail habitat (VTN Colorado, 1975a and 1975b).

(b) Use of habitat types

All sharptail sightings made during the spring of 1974 occurred in sagebrush-steppe and grassland-sagebrush types (table F-3, Appendix F). Summer observations occurred predominatly in the mid-short-grass prairie and sagebrush steppe (54 percent and 30 percent, respectively), and to a lesser degree, in the grassland-sagebrush (8 percent) and agricultural (8 percent) types.

(c) Population characteristics

A high of 17 males was observed dancing on the lek in section 19 for three consecutive days in April 1975 (table 20). Three female sharptails and five young were observed in 1974, while one female and 27 young were observed in the summer of 1975 (table F-4, Appendix F).

Table 20.--Sharp-tailed grouse dancing-ground counts for spring 1975

Number of Males	Date	Location
5	4-17-75	SE¼ sec. 19, T. 9 S., R. 41 E.
14	4-19-75	SE¼ sec. 19, T. 9 S., R. 41 E.
17	4-20-75	SE¼ sec. 19, T. 9 S., R. 41 E.
17	4-22-75	SE¼ sec. 19, T. 9 S., R. 41 E.
17	4-24-75	SE¼ sec. 19, T. 9 S., R. 41 E.
16	4-30-75	SE¼ sec. 19, T. 9 S., R. 41 E.

(6) Hungarian partridge

Four sightings of Hungarian partridge were made during the study period for a total count of at least 43 birds. These birds were seen twice in a mid-short-grass prairie habitat once in a sagebrush-steppe habitat and once in a reclaimed area within the West Decker mine boundary (fig. 56). The Decker area generally represents poor habitat for Hungarian partridge, which are better adapted to areas that are cultivated.

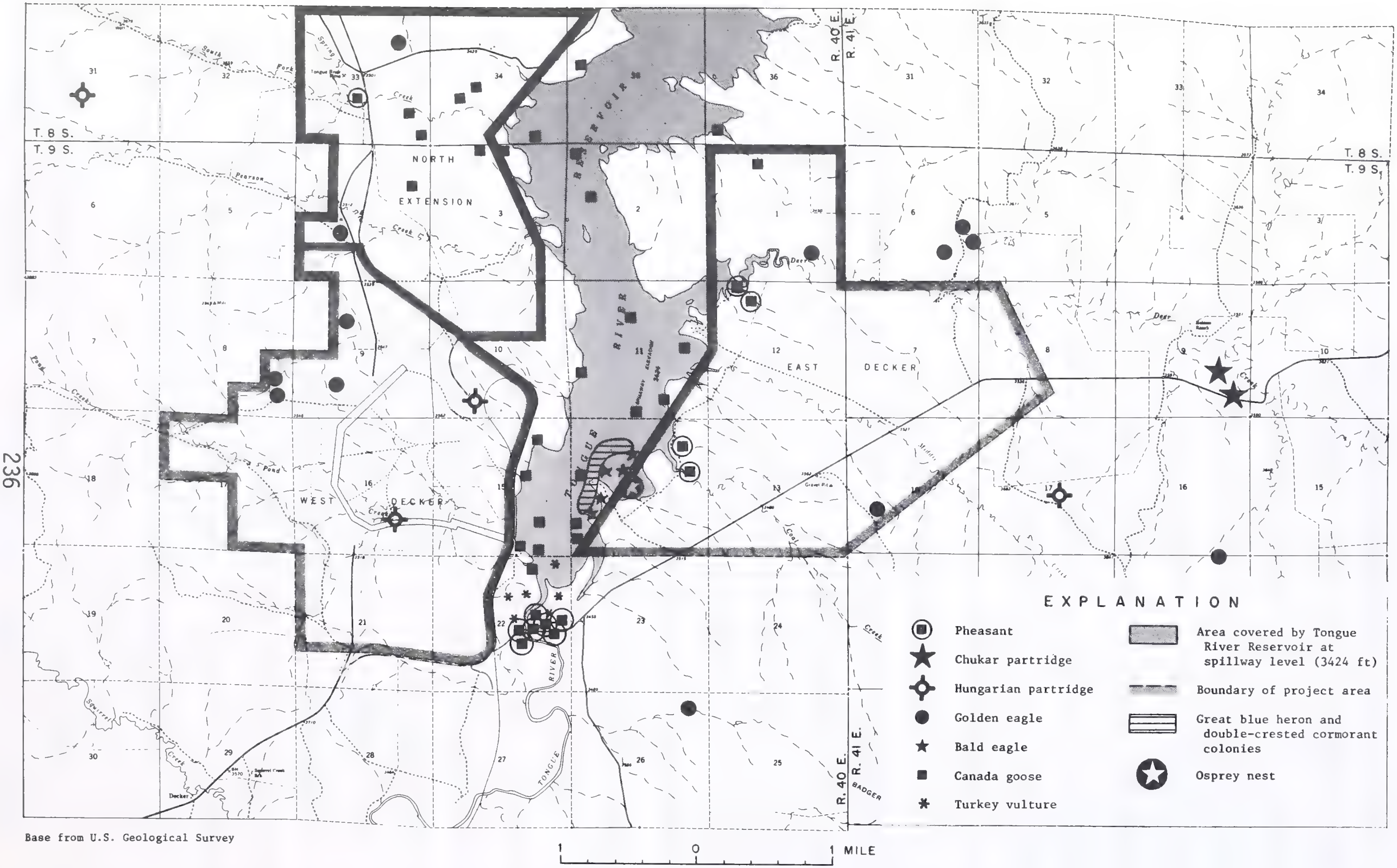
(7) Chukar partridge

VTN Colorado (1975a) reports four sightings of a single covey of Chukars on the eastern border of the proposed East Decker mine site. The Montana Fish and Game Department reported two sightings of 12 birds each in 1975. The first observation was in an agricultural field; the second was on a road (fig. 56). Chukars do not seem to be restricted to a certain habitat type and may be found from riparian bottoms to timberline (VTN Colorado, 1975a).

(8) Ring-necked pheasant

(a) Distribution

Pheasant distribution in the Decker area is closely related to riparian habitats. Recent observations have been made near the bridge where the



Base from U.S. Geological Survey

Figure 56.—Bird sightings and related observations in the Decker area in 1974 and 1975.

county road crosses the Tongue River, in wet bottomland areas along the eastern shore of the reservoir (Fish and Game observations) and in the lower reach of Spring Creek valley (Montana Department of State Lands observation) (fig. 56).

(b) Use of habitat types

Pheasant habitat in the Decker area is confined to the riparian community type where sufficient weed seeds are available for food and where cover is abundant (VTN Colorado, 1975a). Eleven observations of pheasants were made during the study period -- eight in the riparian type adjoining the reservoir and three in agricultural fields adjacent to the Tongue River.

(c) Population characteristics

From January through August 1975, a total of 24 pheasants were observed within the Decker area; of these 6 were males, 5 were females, 9 were young, and 4 were unclassified.

(9) Great blue heron and double-crested cormorant

These two species have nested in a series of rookeries at the upper end of the reservoir for many years in an area adjacent to the western border of the proposed East Decker mine site and railroad spur fill (fig. 56). Knapp (1975a) counted close to 100 breeding pair of great blue herons at this site in 1975, whereas the Montana Department of Natural Resources reports estimates of 60-75 herons and 50-60 cormorants using this area. By mid-October, the herons have generally left the Decker area.

(10) Canada geese

(a) Distribution and use of habitat types

Geese generally use two areas near the Tongue River Reservoir -- the mud flats near the south end of the reservoir, and the shores and stubble fields within the proposed North Extension project area boundary. Birds were observed using mud flats on both east and west shores of the reservoir for feeding. After the mud flats dry out, geese turn to feeding in the stubble fields in sec. 3, T. 9 S., R. 40 E. Canada geese were also frequently observed on the reservoir water surface.

The Montana Department of Natural Resources (1976) reports that the south end of the reservoir is used for nesting purposes:

> "Nine pair of nesting geese have been counted within this area, with most of the nests found on the ground. Three nests were found in trees within the rookery area and are utilized earlier than the heron/cormorant population. Nesting success is considered poor since most of the nests are found on the ground (within the normal reservoir pool) and, similar to most goose-nesting areas, are subject to flooding".

(b) Population characteristics

During the late winter of 1974, only one goose count was made -- 35 birds were observed on March 15 (table F-5, Appendix F). In September 1974, a high count of 138 birds was obtained. For 1975: 27 birds were observed during one count in March; 102 birds were observed during a count on April 2; 23 birds were observed during a count on July 18; and 58 birds were observed during a count in August (high for the month). On September 10, 1975, at a time when seasonal migrants began to use the reservoir as a rest area, a high count of 153 birds was made.

(11) Ducks

Various species of ducks have been observed on the Tongue River Reservoir. Nesting has recently occurred in areas adjacent to both the river and the reservoir (VTN Colorado, 1975a; Montana Department of Natural Resources, 1976). To date the number of nesting pairs in such areas has not been determined.

(12) Osprey

An osprey nest is located in a dead snag near the heron and cormorant rookeries (fig. 56). The Montana Department of Natural Resources (1976) reports:[1/]

> "The summer of 1975 was the first documented use of the nest, although one report indicates some nesting during the past three to five years. It is unknown if the nest was successful previously; however, two young osprey were fledged this past year. Whether past nesting represents the extent of osprey nesting in the area is undermined. It has been suggested that the shallow, upper end of the reservoir represents good osprey habitat. If the birds fledged this past year were the first, it is possible they will return with adults and seek suitable nesting sites. Whether this will occur cannot be established for two to three years since the young osprey will spend their first year in South America.[2/]

[1/] In preparing their section on ospreys, the Department of Natural Resources received data on this nest from the Decker Coal Co. and from the Montana Department of Fish and Game. The ornithologist consulted regarding osprey habitat and migration patterns was Dr. Robert Eng of Montana State University.

[2/] The number of young opsrey fledged in 1975 was three, not two, according to records of the Montana Fish and Game Department. Decker Coal Company reports that in 1975, three birds were hatched; one died in the nest and two were fledged. Steve Knapp, of the Montana Fish and Game Department, saw three young in the nest during an aerial observation on July 29, 1975. Jim Wambaugh of the Montana Fish and Game Department observed three young osprey in flight away from the nest during the summer of 1975.

(13) Bald eagle

(a) Distribution

Like the osprey, bald eagles are not year-round residents of the Decker area. Bald eagles have been observed in the Decker area only during the late winter and early spring. In the spring, eagles move on to their nesting sites, probably in Canada (Montana Department of Natural Resources, 1976).

(b) Use of habitat types

Bald eagles are commonly sighted near the south end of the reservoir feeding on fish in the shallow waters (fig. 56). Eagles also roost in trees along the reservoir edge and river bottom and hunt surrounding areas for small mammals or carrion (VTN Colorado, 1975a).

(c) Population characteristics

During March and April in both 1974 and 1975, five observations of bald eagles were made in the Decker area. The total number of birds counted during this period was eight.

(14) Golden eagle

(a) Distribution

Golden eagles are common year-long residents of the Decker area, nesting four to five miles southwest of the West Decker mine. This nesting area is considered to be the second most dense golden eagle nesting site in the United States (Montana Department of Natural Resources, 1976). Frequency of golden eagle sightings seemed to increase during the winter, suggesting that the Decker area may be used by other golden eagles as a wintering area (VTN Colorado, 1975a).

(b) Use of habitat types

Golden eagle use in the Decker area is confined more to the sagebrush-steppe habitat than around the reservoir (Montana Department of Natural Resources, 1976).

(c) Population characteristics

One golden eagle was observed in April 1974; fourteen sightings were made during the summer of 1975 (fig. 56). VTN Colorado, (1975a) reports a high count of five golden eagles on January 3, 1975. These birds were sighted from the air during a monthly game census and distribution transect in the Decker area.

(15) Turkey vulture

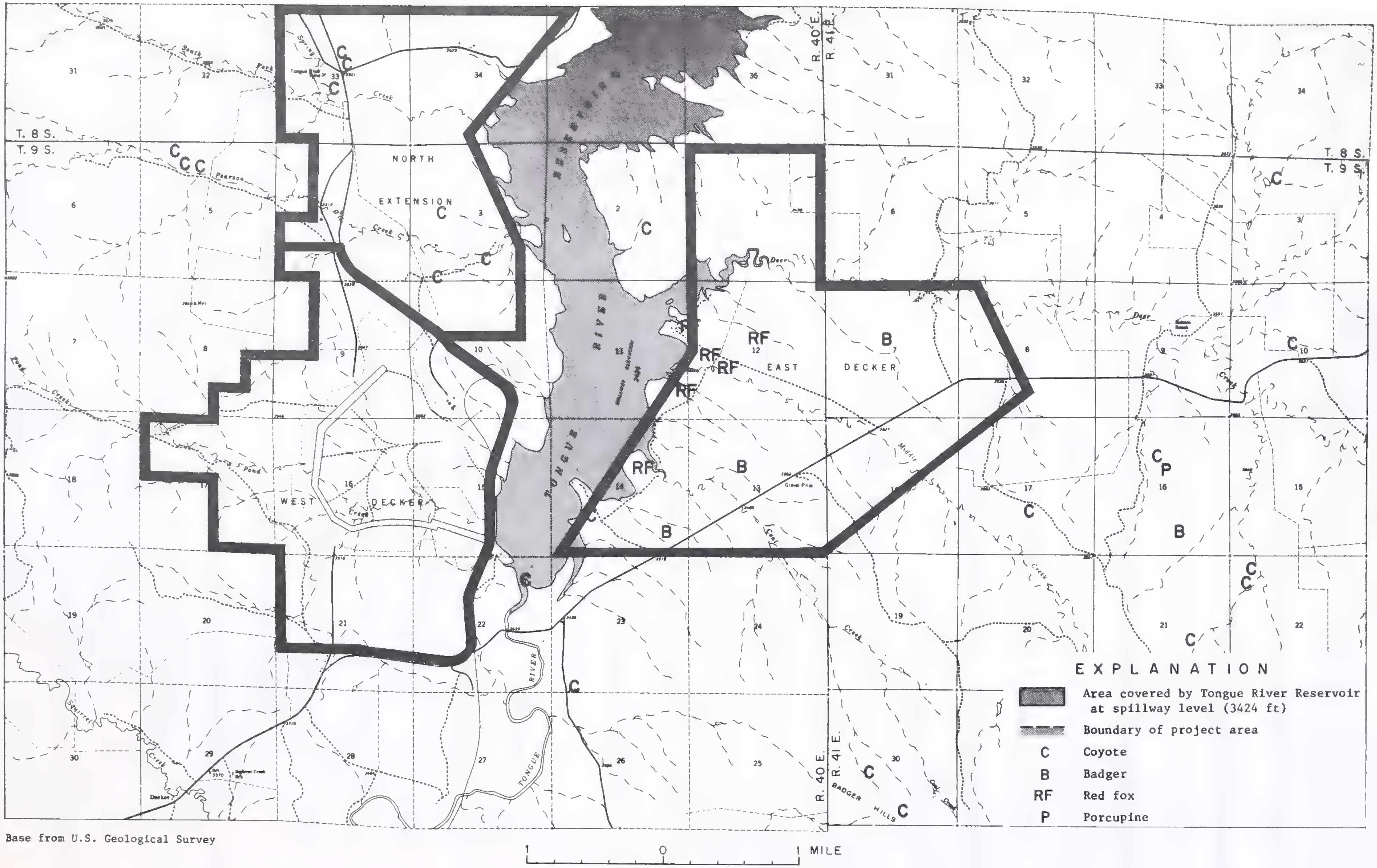
Turkey vultures were observed on six separate occasions during the summer of 1975 (fig. 56). A high count of 29 birds was obtained. Turkey vulture use of the Decker area is limited largely to hunting and feeding. A roost tree has been reported 800-1,000 feet north of the railroad loop site for the proposed East Decker mine (sec. 1, T.9 S., R. 40 E.).

(16) Nongame mammals

Several mammals, including red fox, badger, striped skunk, eastern cottontail, yellow-bellied marmot, porcupine, and coyote, were sighted during the study. Figure 57 shows the location of many of these sightings.

(17) Threatened and endangered species

None of the species listed on either the Montana Endangered Species list nor the U.S. Department of Interior's Threatened Wildlife in the United States, 1973 edition, have been observed in the Decker area (VTN Colorado, 1975a). The whooping crane may be a rare visitor to the Tongue River Reservoir during migration. No confirmed sightings of whooping cranes have been made in the Decker area.



Base from U.S. Geological Survey

Figure 57.—Some nongame mammal sightings in the Decker area in 1974 and 1975.

b. Fish

(1) Background

The Tongue River Reservoir borders both the proposed East Decker and North Extension mine areas. This reservoir is becoming increasingly important as a recreational area including sport fishing.

A variety of sport and nongame fish comprise the warm-water fishery resource of the reservoir. Among the important sport fish are: northern pike, walleye pike, sauger, black and white crappie, large and smallmouth bass, and channel catfish. The remaining and predominant species include: carp, goldfish, golden shiner, shorthead redhorse, sucker, bullhead, sunfish, and yellow perch. No fisheries exist within the proposed mined areas.

The Tongue River Reservoir and a portion of the river upstream were chemically treated in 1957 to remove undesirable fish species. Following rehabilitation, the reservoir was stocked with rainbow trout in an attempt to duplicate the quality of fishing that commonly follows the initial impounding of reservoirs. Over two million rainbows were planted during the years 1958-60. Gill-net sampling showed a dramatic decline in rainbow numbers between 1959 and 1960, however, and trout stocking in the reservoir was terminated because the undesirable fish species had again reached high population levels. As late as 1962, the reservoir still produced good catches of rainbows, with fish ranging from 1½ to 6 pounds being commonly taken.

Warm-water fishes were first planted in the Tongue River Reservoir in 1963 in an attempt to develop a self-sustaining warm-water fishery. A summary of plantings of warm-water fish in the reservoir is presented in table 21.

Table 21.--Summary of warm-water fish plants in the Tongue River Reservoir, 1963-75

Year	Species	Size	Number
1963	Northern pike	Fry	210,000
	Northern pike	Fingerling	35,200
	Channel catfish	3-inch	20,608
1964	Northern pike	Fry	100,000
	Channel catfish	2-inch	99,180
	Largemouth bass	1-inch	150,000
1965	Northern pike	Fry	339,300
	Walleye pike	Fry	750,000
1966	Northern pike	Fry	210,500
	Walleye pike	Fry	100,000
1967	Walleye pike	Fry	197,750
1968	Walleye pike	Fry	601,214
1969	Northern pike	Fry	650,000
	Northern pike	Fingerling	513,200
	Walleye pike	Fry	92,480
1970	Northern pike	Fry	1,125,000
1971	Northern pike	Fry	360,000
1972	Northern pike	Fingerling	14,058
	Largemouth bass	2-inch	199,290
1973	Northern pike	Fingerling	13,184
	Largemouth bass	2-inch	27,540
1974	Northern pike	Fingerling	3,330
1975	Northern pike	Fingerling	26,000

Northern pike fry and fingerlings were stocked from 1963 through 1966 and again in 1969-1975. No northerns were planted in 1967 and 1968 in an attempt to assess the natural reproductive success of the pike. Fingerlings were planted from 1972-1975 instead of fry in order to evaluate differential stocking rates.

Channel catfish were introduced in 1963 and 1964, and large mouth bass were planted in 1964 and again in 1972 and 1973.

Walleye pike were stocked from 1965 through 1969. As the first walleyes planted would have matured in 1970, walleye stocking was temporarily discontinued as a check on spawning success.

(2) Aquatic studies in the Tongue River Reservoir

In the spring of 1975, the Montana Fish and Game Department initiated an intensive fisheries management survey for the Tongue River and Tongue River Reservoir. The objective of the Tongue River Reservoir segment of the study is to obtain baseline information on fish populations in the reservoir and to document angler use and harvest rates. Fish population data will be coordinated with information collected during a limnology study of the reservoir that is currently ongoing. It is hoped that the information provided by these two studies will make possible an evaluation of the effects of strip mining in close proximity to a reservoir.

The initial results of these fisheries and limnology studies in the Tongue River Reservoir are summarized in the following paragraphs. Additional data are included in Appendix F, together with a description of the methods.

(a) Trap netting

Frame net traps were fished during April and May in 1972, 1973, and 1974, and during April through June in 1975 to establish indices of spawning of sport-fish populations in the reservoir. The reservoir was divided into three zones (fig. 58), and the traps were fished in areas that appeared to be good spawning habitat. A total of 19 fish species representing 6 families were trapped during the spring trap-net season of 1975. Trap-net catches for the years 1972 through 1975 are compared in table 22. A summary of the trap-net catches by zone for 1975 is given in table 23.

Carp were the predominant fish in the 1972 sample (37.1 percent of the total) with yellow perch dominant in 1973 (28.6 percent). White crappie predominated in 1974 and 1975, making up 48.6 and 65.5 percent of the total, respectively. Catch rates for white crappie have increased substantially between 1972 and 1975.

Game fish made up 3.3 percent of the total trap-net catch in 1975 as compared to 8.7 percent in 1974. The 1975 trap-net catch rate is similar to the 1972 and 1973 game-fish catches.

Northern pike were taken almost exclusively in the upper end of the reservoir (zone A), with these traps accounting for 91.5 percent of the northern catch. From trap data it appears that northern pike prefer the bays and shallow areas from Deer Creek to the head of the reservoir. Initial trapping studies of the northerns indicate limited natural reproduction in the reservoir.

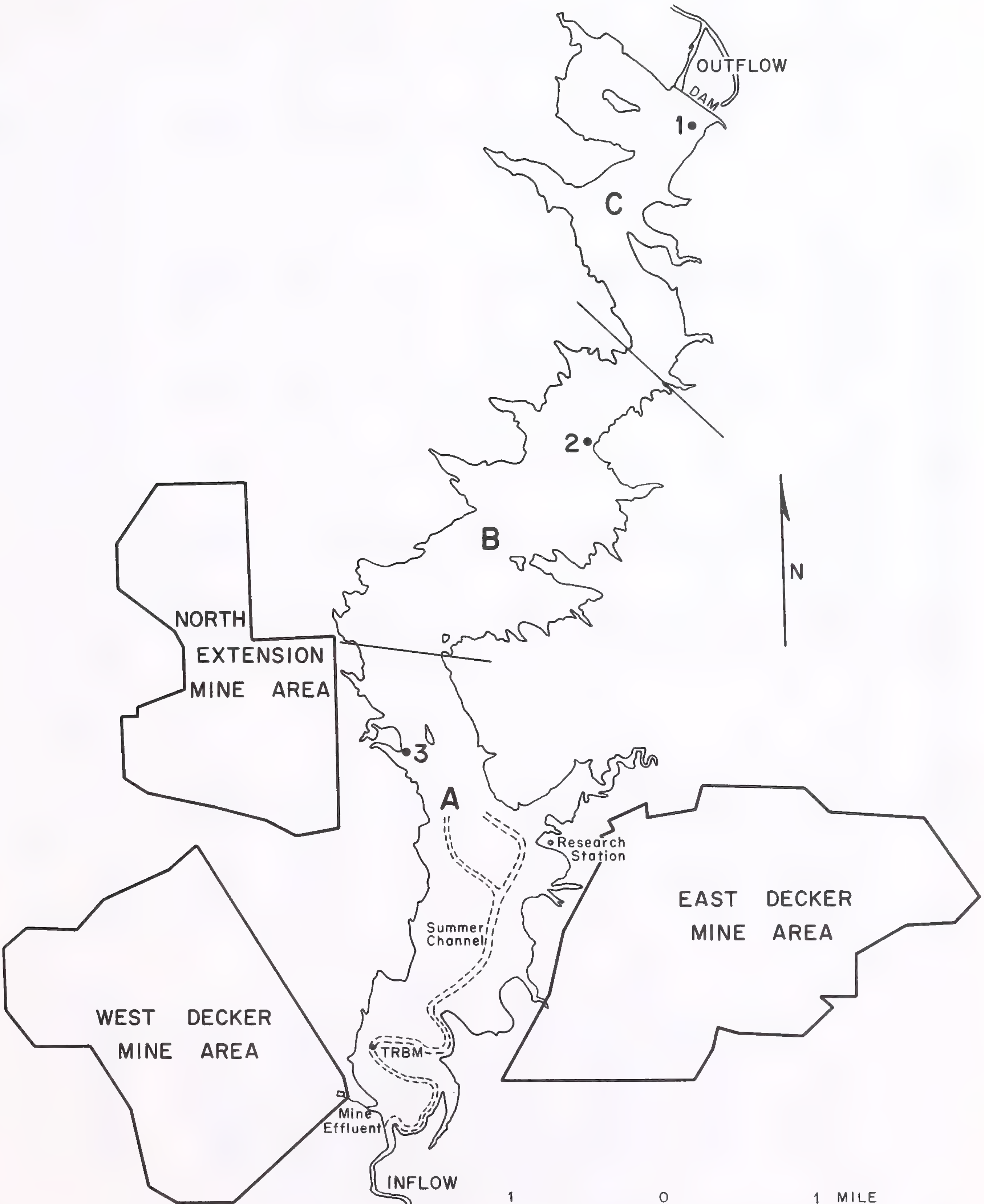


Figure 58.— Map of the Tongue River Reservoir showing the location of the three sampling areas.

Table 22.--Comparison of trap-net catches - Tongue River Reservoir, 1972-75. (Expressed as numbers per net night)

Species	1972		1973		1974		1975	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Northern pike	0.34	1.78	0.25	1.79	0.95	5.79	0.90	1.97
Carp	7.05	37.10	3.39	24.40	1.46	8.90	3.49	7.63
Goldfish	0.01	0.05	0.02	0.14	0.10	0.61	0.22	0.48
Golden shiner	0.09	0.47	0.11	0.79	0.34	0.24	1.24	2.71
Shorthead redhorse	0.13	0.68	0.21	1.51	0.29	1.77	0.16	0.35
White sucker	0.19	1.00	0.49	3.52	0.30	1.83	0.57	1.25
Longnose sucker			0.03	0.21	0.03	0.18	0.01	0.02
Black bullhead	1.51	7.94	0.43	3.09	0.55	3.35	0.27	0.86
Yellow bullhead					0.26	1.59	0.28	0.61
Stonecat			0.01	0.07	0.01	0.06	0.03	0.06
Largemouth bass	0.01	0.05			0.02	0.12		
Smallmouth bass	0.01	0.05	0.01	0.07	0.03	0.08	0.06	0.13
Rock bass			0.01	0.07	0.01	0.06	0.04	0.08
Green sunfish			0.02	0.14	0.02	0.12	0.04	0.08
Black crappie	1.24	6.52	1.30	9.35	2.99	18.24	4.08	8.92
White crappie	1.99	10.47	3.50	25.19	7.96	48.55	29.95	65.50
Sauger			0.02	0.14	0.09	0.55	0.09	0.20
Walleye	0.38	2.00	0.12	0.86	0.33	2.01	0.47	1.03
Yellow perch	6.05	31.84	3.96	28.56	0.96	5.85	3.83	8.34
Total	19.00		13.89		16.40		45.73	
No. trap nights	85		121		168		197	

Table 23.--Summary of trap-net catches by zone in the Tongue River Reservoir, 1975

Species	April			May			June			Total			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Northern pike	67	1	1	89	6	2	5	4	1	161	11	4	176
Carp	195	23	27	264	53	34	10	8	3	469	164	64	697
Goldfish	21		1	11	1		1	8		33	9	1	43
Golden shiner	17	1	1	15	60	8	8	104	8	40	165	17	222
Shorthead redhorse	2			9	5	5	3	4	2	14	9	7	30
White sucker	5		2	1	5	8	2	36	53	8	41	63	112
Longnose sucker	0								1			1	1
Black bullhead	11	1		13	20	4	1	1	3	25	22	7	54
Yellow bullhead	2			2	33	10	1	6	2	5	39	12	56
Channel catfish	0												
Stonecat	0				3			2			5		5
Largemouth bass													
Smallmouth bass					9	1		1	1		10	2	12
Rock bass				1	7				1	1	7		8
Green sunfish	2			1	2	2				3	2	3	8
Black crappie	34		2	62	125	97	31	77	374	127	202	473	802
White crappie	83	2		211	717	89	577	3850	372	871	4569	461	5901
Sauger	2	3		11		2	3	1		16	4	2	22
Walleye	26	31	9	8	3	7	3	15		37	49	16	102
Yellow perch	75	11		9	83	542	2	1	17	86	95	559	740
Total	542	73	43	707	1132	811	647	4198	838	1896	5403	1693	8991
Fish per night	27.1	14.6	14.3	17.2	34.3	35.3	49.7	110.5	39.9	25.6	71.1	36.0	45.6
Trap nights	20	5	3	41	33	23	13	38	21	74	76	47	197

The walleye catch was distributed about equally between zones A and B, contributing 40.7 and 41.7 percent respectively. The remaining 18 percent were captured in zone C. Zones A and B represent the best walleye spawning areas due to the rocky shoals found in these areas. Initial studies indicate that walleye are spawning in the reservoir. Average weights of walleye also show the inclusion of younger fish into the run in 1975.

Crappie showed differential distribution patterns in the reservoir, with 58.7 percent of the blacks being caught in zone C. The remainder of the black crappies were about equally divided between zones A (15.8 percent) and B (17.3 percent). White crappie were most abundant in zone B (77.4 percent), followed by zone A (14.7 percent). Only 7.8 percent of the whites were captured in zone C. This distribution pattern is probably the result of differential water quality between the upper and lower ends of the reservoir and reflects habitat preferences of the two crappie species (Brown, 1971).

The total crappie estimate for 1975 was 47,000 fish, with whites contributing 44,000 (76.8 per acre) and blacks 2,500 (4.40 per acre) (table 24). Estimates of standing crop were 5.51 lbs per acre for white crappie and 0.48 lbs per acre for black crappie. The population strength of crappies in the Tongue River Reservoir appears to be comparable to those found in other areas.

Table 24. --Population estimates of northern pike and black and white crappie determined from trap-net catches in the Tongue River Reservoir, 1974-75.

Species	Year	No. examined	Number recaptured	Population estimate	Confidence interval
Northern pike	1974	169	36	272	
	1975	180	52	228	218-238
Black crappie	1975	861	117	2,526	2,458-2,598
White crappie	1975	5,817	348	44,087	43,389-44,808

Estimates of northern pike greater than 10.8 inches in length were 270 in 1974 and 230 in 1975. Based on the average weight of trap-netted fish, northern pike standing crop was .50 lbs. per acre in 1975 and .44 lbs. per acre in 1975. The population of northern pike in the reservoir is comparatively low, probably as a result of lack of natural reproduction.

(b) Gill netting

Gill-net catches for the years 1964 through 1975 are summarized in table 25. For each year, 18 experimental gill nets were fished on the bottom for a 24-hour period. A total of 21 species of fish representing eight families have been caught in the reservoir. The mean catch rate was 44.9 fish per night. White crappie dominated the catch in seven out of the ten sampling periods. Shorthead redhorse dominated two years and black bullheads the remaining year.

White crappie dominated the 1975 gill net catch (table 26), contributing 30.7 percent of the total catch, followed by shorthead redhorse (23.4 percent), and yellow bullheads (13.5 percent). Game fish made up 10.6 percent of the total, which is comparable to the game-fish catch of 1974 (10.1 percent). Between 1974 and 1975, northern-pike numbers caught declined while sauger and walleye increased.

Northern pike neeted between the years 1974 and 1975 show great variation in average length (fig. F-4, Appendix F). The increased size from 1964-69 followed by a great reduction and then stabilization reveals, as did trap netting, that northern pike are not reproducing successfully in the reservoir.

Gill-netted walleye increased in size from 1966 to 1971 followed by a stabilized level. The inclusion of smaller fish among those netted in 1972 reveals that walleye are successfully reproducing in the reservoir.

Table 25.--Summary of gill-net bottom sets in the Tongue River Reservoir, 1964-75, expressed as numbers of fish per net set

Species	1964	1966	1968	1969	1970	1971	1972	1973	1974	1975
Rainbow trout									0.1	0.1
Northern pike	0.8	0.8	0.1	0.2	0.3	0.2	0.3	1.2	0.6	0.1
Carp	4.2	2.5	4.6	8.4	6.3	4.1	4.6	6.9	3.3	4.8
Golden shiner	12.0	0.3	0.7	0.6	-	0.1	0.2	-		0.1
Goldfish	-	-	0.1	0.2	0.1	0.1	-	0.1		
Longnose sucker	0.5	0.3	0.1	0.2	0.1	-	-	-		0.1
Shorthead redhorse	0.8	9.0	1.2	6.5	3.5	1.7	10.2	21.5	10.3	11.2
White sucker	16.8	3.8	5.0	1.3	2.9	0.6	3.3	4.7	1.9	2.2
Black bullhead	15.2	12.0	4.2	2.8	1.4	0.7	3.7	5.0		0.7
Yellow bullhead								-	2.7	6.4
Channel catfish							0.1			0.1
Stonecat										0.1
Largemouth bass	0.5	-	-	-	-	-	-	-		0.1
Smallmouth bass							0.1	0.3	0.3	1.0
Pumpkinseed sunfish								0.2		0.1
Rock bass								0.2	0.2	-
Black crappie							3.1	0.3	0.3	0.6
White crappie 1/	22.5	9.8	16.8	15.8	9.2	11.3	7.2	11.9	16.4	14.7
Sauger								0.6	1.0	1.4
Walleye pike		0.7	0.1	0.7	0.5	0.4	1.5	2.5	1.7	2.8
Yellow perch	1.5	10.0	4.0	7.7	4.1	8.4	5.6	4.3		1.7
Total	74.8	48.2	36.9	44.4	28.4	27.6	39.9	59.7	40.8	47.9
Number of sets	4	6	18	18	18	18	18	18	18	18

1/ Includes black and white crappie, 1964-1971.

Table 26.--Catch statistics of 18 overnight gill-net bottom sets, Tongue River Reservoir, July 1975

Species	Number	Number per net	Avg. length (inches)	Avg. weight (ounces)
Rainbow trout	1	0.1	7.28	4.94
Northern pike	2	0.1	20.28	30.51
Carp	87	4.8	16.14	29.52
Golden shiner	1	0.1	3.19	1.41
Longnose sucker	1	0.1	9.33	3.88
Shorthead redhorse	202	11.2	12.68	12.80
White sucker	40	2.2	17.77	16.37
Channel catfish	1	0.1	14.02	12.70
Black bullhead	13	0.7	8.94	7.16
Yellow bullhead	116	6.4	8.62	5.36
Stonecat	1	0.1	8.27	3.53
Largemouth bass	1	0.1	5.79	1.41
Smallmouth bass	18	1.0	10.59	10.05
Rock bass	2	0.1	6.61	6.28
Pumpkinseed sunfish	1	0.1	4.96	1.41
Black crappie	10	0.6	4.69	1.87
White crappie	265	14.7	7.80	9.51
Sauger	18	1.4	20.08	19.51
Walleye pike	51	2.8	15.67	27.23
Yellow perch	30	1.7	6.50	1.76
Total	862	47.9		

Smallmouth bass were first gill-netted in the reservoir in 1972. Smallmouth bass have been stocked in ponds left in strip-mined areas adjacent to the Tongue River near Sheridan. High water apparently allowed the smallmouths to escape into the river and then into the reservoir. Smallmouth bass are becoming a favorite fish for anglers in the area.

Sauger were first gill-netted in the reservoir in 1973. This species was transplanted by Wyoming into the part of the Tongue River above the reservoir and are now becoming well established in the reservoir. Initial studies show that sauger prefer the upper end of the reservoir.

(c) Electrofishing

A 2.5 mile section of the Tongue River upstream from the reservoir was electrofished in September 1975. The section was sampled to evaluate species composition and distribution above the reservoir. A total of 322 fish were captured, representing 14 species. Shorthead redhorse predominated, comprising 31.4 percent of the total, followed by carp, which made up 30.4 percent. Sauger and smallmouth bass were the only game fish taken. The presence of young-of-the-year sauger indicates that this species is reproducing in the river.

(d) Tagging

Floy anchor tags were placed on a total of 500 sport fish in the Tongue River Reservoir in order to evaluate growth rates, movement, and relative fisherman harvest (table 27.). Anglers returned 5.3 percent of the northern pike tagged during 1974 and 1975. Walleye returns for this same period were 1.6 percent. The small rate of tag return suggests harvests well within tolerable limits of fish populations.

Table 27.--Summary of tagged fish in the Tongue River Reservoir, 1973-75

Species	1973	1974	1975
Northern pike	41	110	73
Walleye	10	34	79
Sauger	1	9	12
Largemouth bass		2	4
Smallmouth bass	2	3	49
Black crappie		19	36
White crappie		6	7
Channel catfish			3
Total	54	183	263

(e) Creel census

A partial creel census was made in 1975 and 1976 to sample anglers as they left the Tongue River Reservoir. Results of the creel census are given in section II. C. 7. Census sampling methods are given in Appendix F.

(3) Proposed mine--spawning area relationships

Two reservoir areas are of special concern to the East Decker mine application, they are the reservoir bay at the mouth of Deer Creek and the bay immediately to the North of Deer Creek (fig. 3). Deer Creek bay is not heavily used as a spawning area by warm-water fish in the reservoir. The bay immediately north of the Deer Creek bay, however, is a major reservoir spawning area for rockbass, smallmouth bass, and crappie. The eastern shore of the reservoir adjacent to the proposed railroad spur is not an important spawning area because of the poor bottom substrate (personal communication, Al Elser, Fisheries Biologist, Montana Fish and Game Department).

C. The social and economic environment

1. Description of studies

Sheridan, Big Horn, and Rosebud Counties have been defined as the local social and economic impact area (fig. 59). Choice of this study area was dictated by a desire to block out an area of sufficient size to encompass local and dispersed mine impacts.

Statistical data are usually collected by political or administrative boundaries, with county level data being the most consistent common denominator. Social and economic patterns, however, do not respect county lines. It is quite possible for the social impact of the proposed mines to be felt beyond the immediate Sheridan-Decker locale. On the other hand, demographic impacts may not carry so far. To outline a consistent maximum boundary for impact analysis, the three-county area was selected.

The proposed mine sites are located in the eastern panhandle of Big Horn County. The southern portion of Rosebud County lies only a few miles to the north, but there are few economic and social links with the project sites. Sheridan County lies to the south of Big Horn County and contains the city of Sheridan, the trade and services center for this region. Both projects are within 30 miles of Sheridan, where most of the economic impacts are projected to occur. Therefore, the major emphasis in the following analyses is placed on existing social and economic conditions in Sheridan County.

Three studies comprise the major part of the discussion of the socioeconomic environment and the resultant impacts on this environment by the addition of the new Decker mines. A demographic analysis reviews

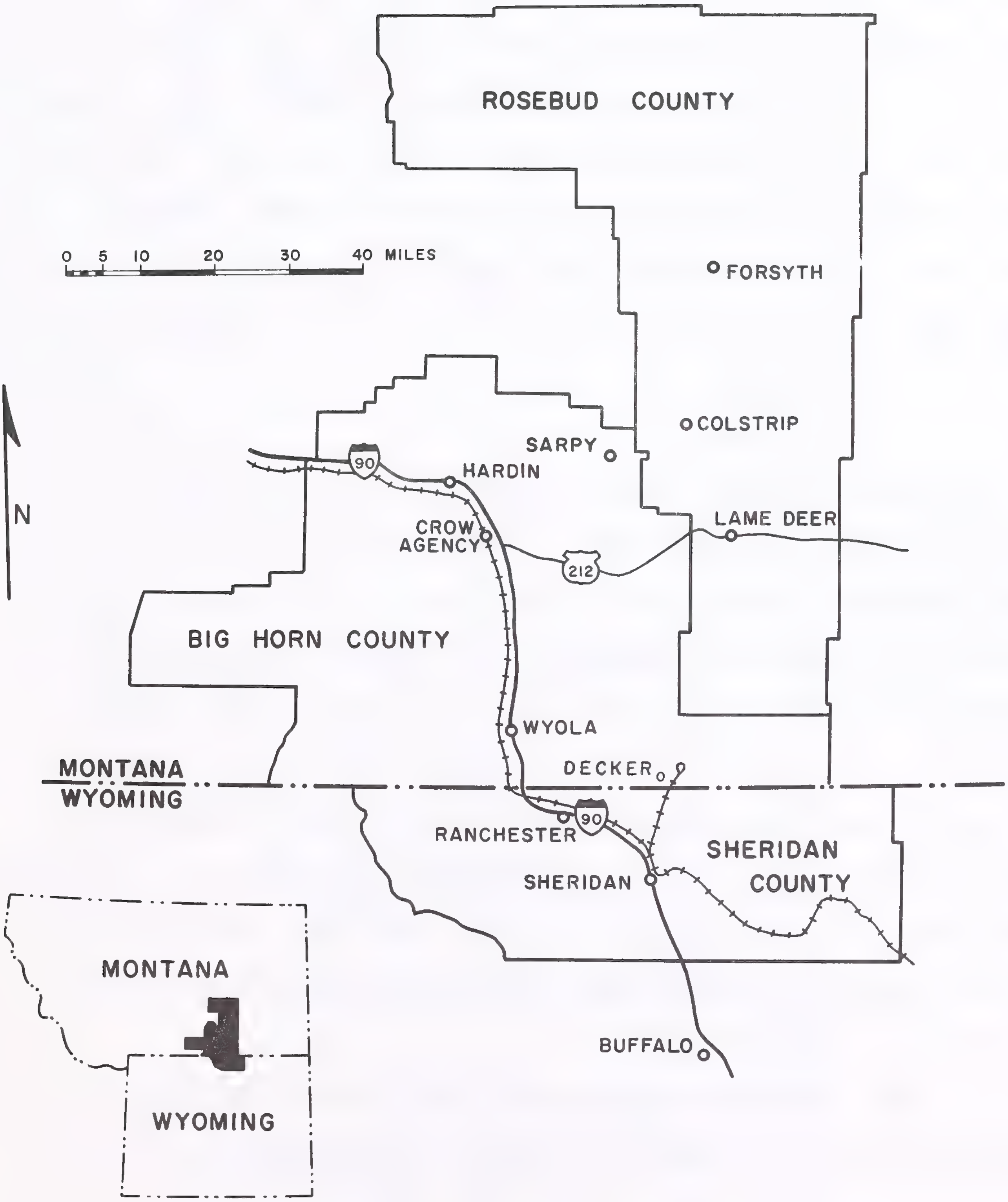


Figure 59. – Socioeconomic study area.

population impacts, especially the prognosis for population growth (Fitzpatrick, 1975). An economic section focuses upon the mines' influence on employment, income, taxes, and government expenditures (Polzin, 1975). A social impact portion treats the effect of the mines on the local social structure and social delivery systems (Institute for Social Research, 1975). These three studies were contracted by the Department of State Lands specifically for the purpose of inclusion into this Environmental Impact Statement. Descriptions of the methodologies used, together with additional tables and text material for portions of these studies are found in Appendix G.

2. Population

a. Trends

Since 1960, the level of population within the three-county impact area has remained relatively static. The period 1960-1970 was marked by a small population decline. From 1970-1974 the U.S. Census Bureau (1971) reported a reversal in the downward trend of the 1960's. Rosebud County reported a 27.7 percent increase in five years; Sheridan County grew an estimated 8.1 percent, and Big Horn County had a 4.4 percent growth rate.

In all three counties a stimulus to population growth appears to have been coal development. The three-county study area now contains six operating strip mines. Four of the mines were opened after 1968. One coal-fired electric generating plant has been completed and another is under construction at Colstrip in Rosebud County.

Table 28 illustrates the population trends in the study area. The populations of the respective county seats, census divisions adjacent to

Table 28.--Population change (Fitzpatrick, 1975)[1]

	1960	1970	1974[2]	Change 1960-1970 (percent)	Change 1970-1974 (percent)	1970 Population density (persons per mile)
BIG HORN (county)	10,007	10,057	10,500	+ 0.5	+ 4.4	2.0
Hardin (city)	2,789	2,733	NA	- 2.0	NA	NA
Busby-Decker (census division)	1,012	1,036	NA	+ 2.4	NA	NA
ROSEBUD (county)	6,187	6,032	7,700[3]	- 2.5	+27.7	1.2
Forsyth (city)	2,032	1,873	NA	- 7.8	NA	NA
Ashland-Lame Deer-Birney (census division)	2,076	2,635	NA	+26.9	NA	NA
SHERIDAN (county)	18,989	17,852	19,300	- 6.0	+ 8.1	7.1
Sheridan (city)	11,651	10,856	NA	- 6.8	NA	NA
Sheridan west (census division)	2,970	2,570	NA	-13.5	NA	NA
MONTANA (state)	674,767	694,409	735,000	+ 2.9	+ 5.8	4.8
WYOMING (state)	330,066	332,416	359,000	+ 0.7	+ 8.0	3.4

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[1] Sources: U.S.Department of Commerce, Bureau of Census, (1970a, 1970b, 1975).

[2] Population figures for 1974 are preliminary mid-year estimates developed by the U.S. Department of Commerce, Bureau of Census (1975).

[3] The 1974 estimate for Rosebud County is significantly lower than estimates developed by state, private, and other governmental agencies. The Montana Department of Natural Resources and Conservation forecast the 1975 county population at 9,357 (Montana Department of Natural Resources, 1974, p. 784). The Rosebud County Planning Board reported a "best quess" population estimate of 9,100.

the mine sites, and states are also reported. During the decade of the 1960's, the study area failed to keep pace with growth ratio statewide for both Montana and Wyoming. Since 1970, however, statewide growth has been surpassed by regional increases within the study area. All three counties have low population density.

b. Population structure

Sheridan County has a bimodal population pyramid with large numbers of children and elderly (fig. 60). The middle-aged groups are small by comparison. The median age in the county is significantly higher than the State median. Among Wyoming counties, Sheridan has the second highest median age. Across the border in Montana the opposite is the case. Both Rosebud and Big Horn have very young populations, and their respective population pyramids are both triangular in shape (figs. 61 and 62). Age cohorts with the highest representation are those for children. This is not unusual for areas with large minority (American Indian) populations. The median age for both Rosebud and Big Horn Counties is significantly lower than the State median (see table G-1, Appendix G).

All three counties contain approximately equal numbers of males and females. Racially, Sheridan County is unlike Big Horn and Rosebud Counties. The latter contain large populations of American Indians (38.9 percent and 30.2 percent respectively). Sheridan County has a minute (approximately 0.6 percent) Indian population (see table G-1, Appendix G).

Big Horn and Rosebud Counties exceed the Montana average for persons per household. Again, a high number of person per household is not unusual

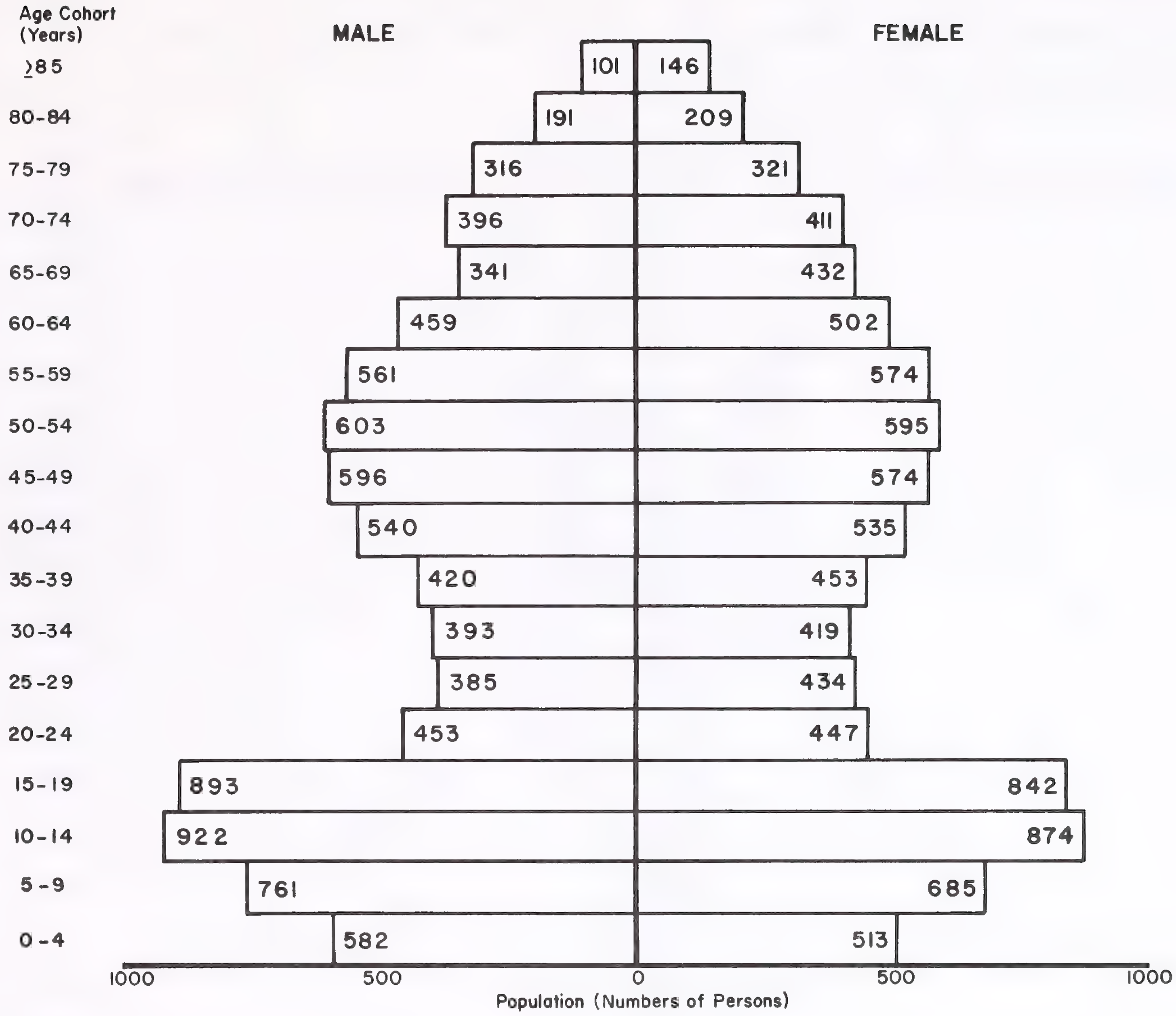

Figure 60.—Population by age and sex, Sheridan County, Wyoming.

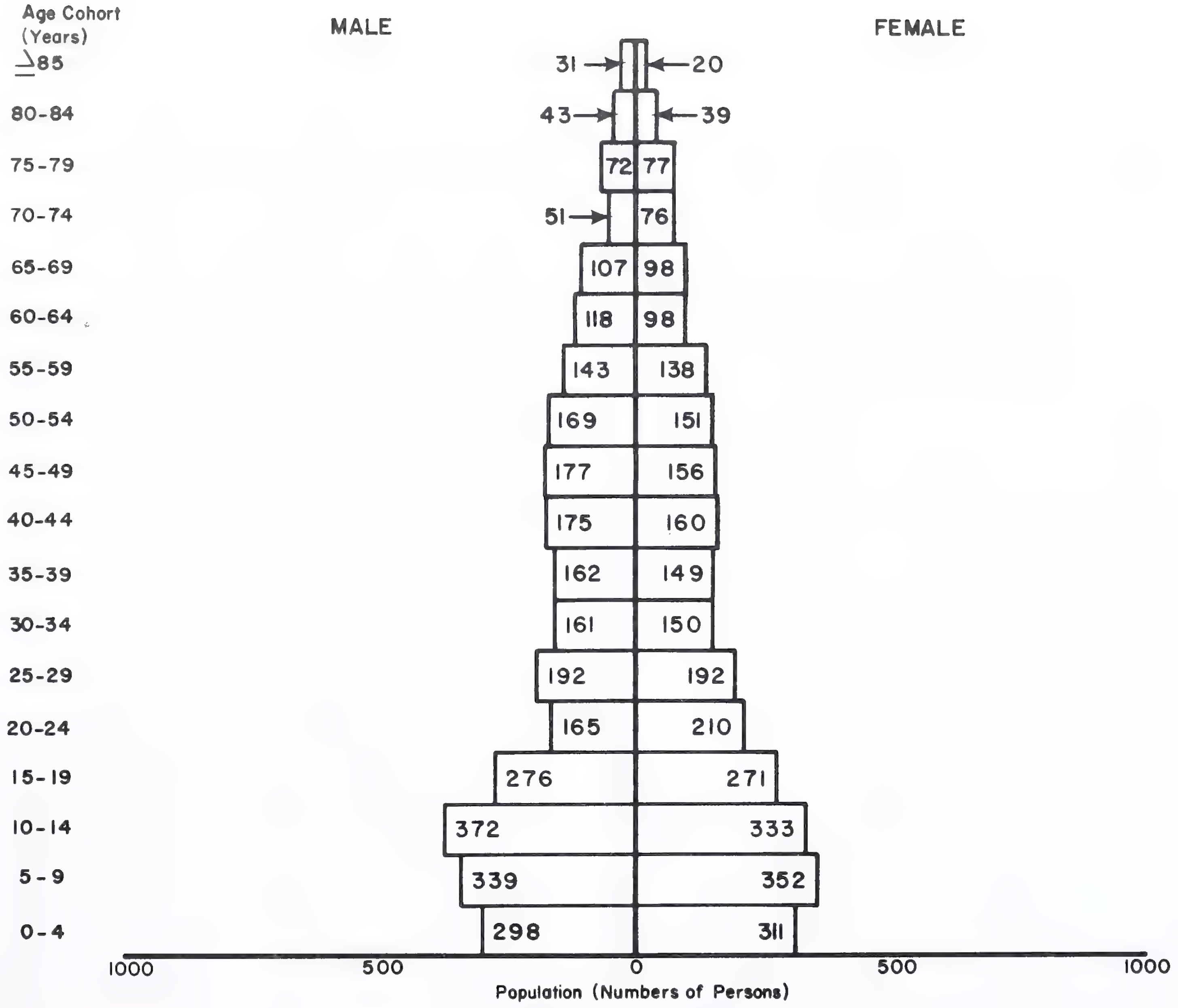

Figure 61.—Population by age and sex, Rosebud County, Montana.

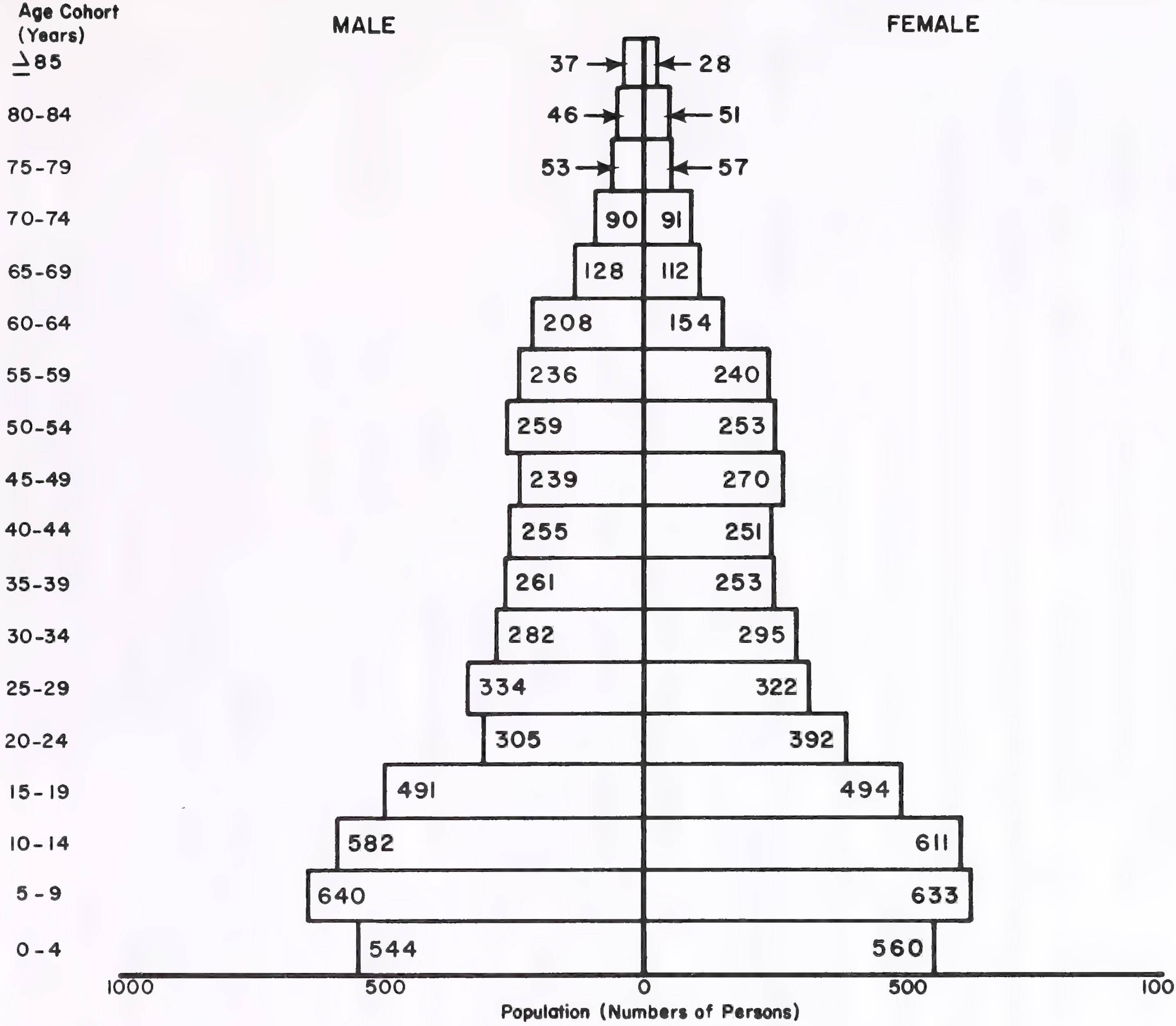

Figure 62. - Population by age and sex, Big Horn County, Montana.

for counties with a sizeable minority population. Sheridan is below the Wyoming average. All three counties have a similar percentage of married individuals but differ in the estimated number of children per married couple (see table G-2, Appendix G).

c. Rates of increase/decrease

The dissimilarity between Sheridan County and the Montana counties is also evident in birth and death rates. Sheridan is unique with its death rate approximating the birth rate. Natural increase as a growth mechanism is negligible. Big Horn and Rosebud counties illustrate high rates of birth and natural increase (table G-4, Appendix G).

Rates of natural increase are strongly tied to age and racial characteristics, and accordingly, such rates within Big Horn and Rosebud Counties are closely related to the influence of youth and the presence of a large Indian minority. As a general rule, younger populations produce more children than do older populations. The frequency of Indian pregnancies, especially among rural and reservation Indians, is markedly higher than for comparable groups of whites (U.S. Department of Agriculture, Economic Research Service, 1975).

In Sheridan County, static or declining population levels have been caused by steady streams of outmigrants. Likewise, Sheridan County's low rate of natural population increase is partially attributable to its age distribution and racial composition. Middle-aged people, those who bear children and raise families, are relatively few (fig. 60).

Rates of natural increase have a number of implications. They specify the internal growth potential of an area, outline the potential reserves of manpower, and serve as a measure of social and economic change. In attempting to estimate the demographic change, the effect of natural increase must also be considered. The scope of population migration to or from the three county impact area will be tempered by local, natural growth. Population changes triggered by the new Decker mine porposals are additive to the existing patterns of change.

3. Land use

a. Present

Most of the land within the three-county impact area is classified as agricultural and is used primarily for grazing. Typical land-use patterns for the three-county area are summarized in table 29 (VTN Colorado, 1975a).

Table 29.--Typical land use for Sheridan County, Wyoming, and Rosebud and Big Horn Counties, Montana (U.S. Dept. Commerce 1969)

Land-use classification	Percent of area	Type of classification
Agricultural	90	90 percent - grazing (extensive agriculture); 6.2 percent - croplands (intensive agriculture) -- only slightly more than half of this land is actually used, the remainder is idle; 3.8 percent - other cropland
Nonagricultural	10	residential areas, streams, and other water bodies

Considerable portions of Big Horn and Rosebud Counties fall within the Crow and Northern Cheyenne Indian Reservations. Parts of southern Rosebud County are included in the Custer National Forest; parts of western Sheridan County are included in the Big Horn National Forest.

Table 30 shows land use within the corporate limits of Sheridan, Wyoming, for the years 1965 and 1976. Data for 1965 are from a land-use survey by Bucher and Willis (1965). Data for 1976 are from a land-use field survey recently completed by the Sheridan Area Planning Agency. Results of this survey will be included in a comprehensive plan currently under preparation for the city (Bernie Spielman, Economist, Sheridan Area Planning Agency, oral communication, February 4, 1977).

The previous surveys show that the percentage of commercial lands in Sheridan is above average for a city of its size. This reflects a retail service center that serves a large trade area which extends outward some distance beyond the city's corporate limits.

For the most part, the distribution of land uses in Sheridan is not greatly different from that in other U.S. cities of comparable size. The developed area within the city, however, does have nearly twice the normal area per capita dedicated to parks and recreational facilities and less than the normal area per capita alloted to industrial uses.

According to table 30, the total area within the city in 1976 was 2,650 acres. Of this total, 453.4 acres or 17.1 percent were vacant. Population density for the developed area in Sheridan was 16.64 acres per 100 persons in 1976 (table 30).

The increased percentage of vacant land in Sheridan in 1976 compared to 1965 indicates that the city is incorporating areas in which growth is projected in an attempt to maintain a stable tax and city service base. Most of this vacant land occurs in the peripheral areas of the city along U.S. Highway 87 in the southern part of town and along Goose Creek in the western part of town.

Table 30.--Land use within Sheridan, Wyoming for 1975 and 1976 (data from Bucher and Willis (1965) and from Sheridan Area Planning Agency land-use field survey (1976)).

Land-use types	Total acres		Acres/100 persons		Percent of developed area		Percent of developed area in typical U.S. city
	1965	1976	1965	1976	1965	1976	
Residential							
Single-family	651.4	777.5	5.42	5.89	35.1	35.4	39
Two-family	27.4	12.1	.23	0.09	1.5	0.55	2
Multiple-family	24.4	27.0	.20	0.20	1.3	1.23	1
Mobile homes	--	31.0	--	0.23	--	1.41	
Commercial	116.8	128.9	.97	0.98	6.3	5.87	4
Industrial[1]	75.0	140.0	.63	1.06	4.0	6.37	8
Parks & recreational	170.1	211.8[2]	1.42	1.60[2]	9.2	9.64	5
Public & semipublic	167.0	143.3[3]	1.39	1.09[3]	9.0	6.52	9
Streets & alleys	625.6	725.0	5.22	5.49	33.8	33.01	32
Developed area	1,857.7	2,196.6	15.48	16.64	84.0	82.89[4]	
Vacant area	351.6	453.4	2.93	3.43	16.0	17.11[4]	
Total city area	2,209.3	2,650.0	18.41	20.07			

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[1] Includes railroads.

[2] Excludes schools.

[3] Includes schools.

[4] Percent of total area.

b. Land-use planning

Big Horn and Rosebud Counties, Montana, and Sheridan County, Wyoming, are all presently sites of coal-mining activities and associated industries. The anticipated opening of new mines or mine expansions in this area points out the necessity for the adoption of comprehensive land-use plans. Land misuse in these areas is almost a certainty should such plans not be adopted and implemented.

Big Horn and Rosebud Counties and municipalities within these counties have created land-use planning boards which, through their actions, hope to negate adverse impacts that the anticipated population increases may pose. In addition, Big Horn and Rosebud Counties have each adopted county subdivision regulations and have proposed county land-development control ordinances.

The city of Sheridan has an active planning commission that has adopted zoning and subdivision regulations. Such regulations, however, have no control beyond the corporate limits of the city.

The towns of Ranchester, Dayton, Story, Big Horn, and Clearmont (all in Sheridan County) and the city of Sheridan have recently joined with the county of Sheridan in recognition of the need for comprehensive planning and cooperation in controlling future growth (Sheridan Press, April 3, 1975). The Sheridan Area Planning Agency has been formed to conduct planning studies and to recommend needed zoning and subdivision regulations. Such cooperation on area-wide planning by the county and its incorporated areas provide a starting point for defending against uncontrolled growth.

Sheridan County has subdivision regulations and may strengthen them and adopt zoning ordinances upon the recommendations of the Sheridan Area

Planning Agency. In addition, the Sheridan County governing body has applied for Federal planning funds to begin a comprehensive planning effort. Some funding has been recieved (see Appendix G). To qualify for such assistance, the Sheridan Area Planning Agency has collected extensive land-use, housing, population, and economic data from which to formulate comprehensive plans for the county and its incorporated towns. As of February 1977, this initial step in the planning process was nearly completed. Results of this planning are discussed in greater detail in the chapter on mitigating measures (section IV. C. 3.).

4. Local economy

a. Overview of the impacted area and its economic base

The three-county impact area may be characterized as a sparsely populated region whose economy has been oriented toward agriculture. With the exception of the city of Sheridan, the area has been predominately a rural agricultural region with livestock grazing as the primary economic base. The city of Sheridan has developed as a trade center serving the surrounding farms and ranches.

Farms and ranches in the three-county impact area may be characterized as large, efficient, and relatively profitable. They have specialized in livestock production, which makes the best use of the vast tracts of rangeland; although, crops do provide a significant source of revenue. During 1970, almost 80 percent of the cash receipts from farm marketings were from livestock sales, and the remaining 20 percent were from the sales of crops.

The average farm or ranch in the three-county impact area was about 5,100 acres during 1969, almost double the statewide average for Montana and approximately 27 percent larger than the corresponding figure for Wyoming. Net income per farm or ranch was above the averages for Montana and Wyoming; but, because most land is devoted to grazing, the income per acre was below the statewide figures.

b. Employment and earnings

Bureau of the Census figures show farm and ranch workers represented about 18 percent of total employment in the impact area during 1970 (U.S. Department of Commerce, Bureau of Census 1971a, 1971b). This figure was higher in rural Big Horn and Rosebud Counties and somewhat lower in Sheridan County, reflecting Sheridan's role as a trade center (table 31). The remaining portion of the basic (or export) sector in 1970 consisted of small manufacturing firms, including a carpet mill and sawmills, and several coal strip mines -- the Big Horn mine near Sheridan and the Peabody and Western Energy mines at Colstrip (U.S. Department of Commerce, Bureau of Census 1971a, 1971b).

The census data for 1970 are outdated; such data, however, are the most complete and authoritative currently available. Census data for 1970 indicate that approximately 2 percent of civilian employment in the impact area was attributable to the mining industry. The opening of new mines near Decker (West Decker mine) and Sarpy Creek (Westmoreland) in Big Horn County and the rapid expansion of existing mines since 1970 has undoubtedly resulted in greater mining-industry employment within the impact area (tables 32 and 33).

Per capita personal income in the impact area during 1973 was approximately equal to the statewide averages for Montana and Wyoming (table G-11, Appendix G). During previous years, however, incomes in Big Horn County and, to a

Table 31.--Civilian employed persons by major industry group, Big Horn and Rosebud Counties, Montana, and Sheridan County, Wyoming, 1970[1/]

	Civilian employed persons				Percentage of Total		
	Big Horn County	Rosebud County	Sheridan County	Impact area	Impact area	Montana	Wyoming
Agriculture, forestry, and fisheries	885	511	798	2,194	18.2	13.4	10.0
Mining	--	63	182	245	2.0	2.4	9.0
Construction	162	117	430	709	5.9	6.4	6.9
Manufacturing	317	174	300	791	6.6	9.7	6.4
Transportation, communication, and public utilities	132	151	455	738	6.1	8.0	8.9
Wholesale trade	35	6	177	218	1.8	3.8	2.7
Retail trade	509	309	1,395	2,213	18.3	18.5	17.6
Finance, insurance, and real estate	62	53	214	329	2.7	3.9	3.3
Business, personal, health, and professional services	309	208	1,645	2,162	17.9	16.1	16.8
Education and public administration	655	437	929	2,021	16.8	16.2	16.9
Welfare, religious, and nonprofit organizations	97	209	138	444	3.7	1.8	1.4
All employed persons	3,163	2,238	6,663	12,064	100.0	100.0	100.0

[1/] Sources: U.S. Department of Commerce, Bureau of Census, (1971a, tables 55 and 123) percentages derived.
U.S. Department of Commerce, Bureau of Census, (1971b, tables 55 and 123) percentages derived.

Notes: The data pertain to persons sixteen years of age or older who are in the civilian labor force. Percentage detail may not add to total because of rounding.

Table 32.--Annual coal output for major coal mines, Rosebud and Big Horn Counties, Montana, 1968-74

			Annual coal output in thousands of tons				
Company	1968	1969	1970	1971	1972	1973	1974
Western Energy	150	521	1,658	5,161	5,501	4,254	3,212
Peabody Coal	-	164	4,432	1,495	1,601	1,972	2,229
Decker Coal	-	-	75	-	793	4,159	6,874
Westmoreland Resources	-	-	-	-	-	-	1,500

Source: Montana Energy Advisory Council (1974).

Table 33.--Projected annual coal output for major coal mines, Rosebud and Big Horn Counties, Montana, 1975-80

	Projected annual coal output in thousands of tons					
Company	1975	1976	1977	1978	1979	1980
Western Energy	523	10,430	13,500	14,900	17,700	19,100
Peabody Coal	3,000	3,000	3,000	3,000	3,000	3,000
Decker Coal	8,250	10,900	10,900	14,500	12,000	13,900
Westmoreland Resources	4,000	4,000	6,500	6,500	6,500	6,500

Source: Montana Energy Advisory Council (1974).

lesser extent, Rosebud County were below the average for Montana. A period of prosperity in agriculture occurred during 1972-73 and was primarily responsible for the rising incomes. The wholesale price of beef declined, however, during 1974-76, and there is considerable doubt whether these conditions will continue.

The unemployment rate averaged about 4.4 percent of the civilian labor force in the impact area during 1970 (table G-7, Appendix G). But, on the two Indian Reservations (Crow and Northern Cheyenne), the figures were between 11 and 12 percent (U.S. Department of Commerce, Bureau of Census 1971a, 1971b). In addition, there was significant "disguised unemployment"--including persons who would like to work but are not actively seeking employment--which was most severe among Indians, females, and young people. In general, it appears that the slowly growing economy in the impact area has not provided sufficient employment opportunities for those wishing to work, and that there is a surplus labor pool which may be available to fill some of the new positions when they are created.

The earnings of workers in the impact area, except in a few agricultural occupations, were generally lower than their counterparts elsewhere in Montana and Wyoming (table G-10, Appendix G). This is characteristic of a slow-growing area with an excess labor supply.

The elderly comprised a disproportionately large share of the city of Sheridan's population during 1970. This is reflected in the income statistics, which show transfer payments (including Social Security and other retirement benefits) as an important income for residents. Also, the incidence of poverty among unrelated individuals, which may include older persons whose spouse may have died, was significantly greater in Sheridan County.

c. Government expenditures and revenues

Expenditures by cities, counties, and school districts have increased significantly during the last decade (table G-15, G-16, and G-19, Appendix G). The burdens on the individual property taxpayers, however, have not grown proportionately. The Montana counties appear to have experienced rapid increases in assessed evaluation and moderate declines in property-tax mill rates as coal-related projects are added to the tax rolls. In Rosebud County, which was the first Montana county to experience significant coal development, property-tax mill levies peaked during the early seventies and then declined as the assessed valuation of the coal mines and electrical generating plants were added to the tax base. The total mill levy in Big Horn County decreased sharply during 1975, possibly the result of adding the West Decker and Westmoreland mines to the tax base.

Property taxes in Sheridan County have increased moderately but not as a direct result of local development. In Wyoming, a significant share of the State sales, cigarette, and gasoline taxes are distributed to local governments. These payments, plus the growth in other nontax revenues, have helped to dampen the increased burden on local property taxpayers.

5. Social structure and social services

a. Sampling and survey procedures

A study of the social structure and social services was conducted in the Sheridan-Decker area in the summer of 1975 by the Institute for Social Research, University of Montana. Emphasis in the study was directed toward Sheridan, the city where most Decker employees currently live.

A sample size of approximately three percent of all residential units was chosen using residents listed in the 1974 Polk city directory of Sheridan.

One hundred and twenty respondents, (three percent of all residential units), were selected in accordance with standard random selection procedures. A sample of 120 for the population of Sheridan provides data at the 95 percent confidence interval which is between the .05 and 0.1 precision levels (Institute for Social Research, 1975).

To readily standardize and quantify information, a questionnaire was administered in face to face contacts with the randomly selected respondents. The results of the survey were coded for computer analysis, and after key punching and verification, the data was run using the "CROSSTABS" computer program. The questionnaire administered and the responses received to each of the questions are given in Appendix G.

In addition to the 120 residents randomly interviewed, personal interviews were also arranged with various agency personnel, politicians, businessmen, and other informed people in and around Sheridan to obtain in-depth data on various dimensions of social impact.

The impacts of the proposed new Decker mines upon the social structure and social services of Sheridan were derived and analyzed using three primary sources: (1) results of the questionnaire, (2) personal interviews with community officials and business leaders, and (3) related research in southeastern Montana and northeastern Wyoming (U.S. Bureau of Reclamation and Center for Interdisciplinary Studies, 1974; Institute for Social Research, 1974a, 1974b, 1975a; Intermountain Planners and Wirth-Berger Associates, 1974; Jobes and Parsons, 1975; Montana Academy of Sciences, 1975; Northern Great Plains Resources Program Staff, 1975). One member of the Institute's research team had been living in Sheridan and doing social impact research in and around the town for about a year before this contracted study on Decker's proposed mine expansions. What he had learned there greatly facilitated developing a questionnaire and interpreting findings. The other two members of the team had been conducting similar research in southeastern Montana and northeastern Wyoming for over two years and in the Decker area (including Sheridan) earlier in 1975.

b. Setting

Located at the base of the Big Horn Mountains, Sheridan is a very attractive place with a tradition of low-cost housing and rent. It is a traditional, conservative town, favored for retirement by many of the rural people in the area. More than a quarter of its residents are age 60 and over; most of them own their homes and live in middle-class sections of town.

Until recently the population of Sheridan had remained almost the same since the 1920s. At various times Sheridan has had a sugar beet plant, a flour mill, and a brewery; all are now defunct. Sheridan County's underground coal mines closed many years ago.

Sheridan's population (10,856 in 1970) is now around 13,000 (summer, 1975). The Sheridan County Assessor's figures indicate that the county's population has increased by 4,200 since 1970.1/ Apparently, about half of this increase has occurred in the city of Sheridan.

1/ In comparing the County Assessor's figure with the much lower 1974 Bureau of Census estimate used in table 25, it should be noted that the Assessor's figures are supported by other ongoing estimates of population changes made by such knowledgeable locals as employment and health agency personnel. The County Assessor's figure is, therefore, more likely to be correct than the official census figure given in table 25. The Institute for Social Research's estimate of the city of Sheridan's present (summer of 1975) population is also consistent with the Assessor's figure.

Over 80 percent of Sheridan's residents live in permanent single-family houses. In addition to the approximately 200 mobile homes in Sheridan, more than 100 additional mobile homes are located within a few miles of town. There has been little home or apartment construction since World War II, an important factor in accounting for both the general housing shortage and the addition of mobile homes.

Sheridan has recently been attracting increasing numbers of itinerant job seekers who wish to be on hand when the Decker Coal Co. starts hiring workers for its expanded operations. Other recent immigrants work at Gillette in Campbell County, Wyoming, or for Texaco in Johnson County, Wyoming.

Fully two-thirds of Sheridan's residents have been there much or all of their lives. Approximately 6 percent of its adults have resided there for less than one year, 11 percent for less than three years, and 21 percent for less than five years.

Sheridan is a regional shopping center for northeastern Wyoming and southeastern Montana. About three out of every ten heads of households are in the professional/managerial/supervisory category, and four out of ten are in blue-collar or white-collar positions other than professional, managerial, or supervisory.

Residents of Sheridan are oriented much more toward Billings, Montana, than toward Casper or Cheyenne, Wyoming, for better shopping facilities, health services, and the like.

Underground mining was an important industry in the Sheridan area for many years. In the past few years, however, strip mining has come into prominence and has now replaced underground mining in extent and economic importance.

c. The people

(1) The employed

More than 23 percent of the respondents in the Institute's survey were retired, and 4 percent were not employed for other reasons; 31 percent were employed as professionals, managers, or supervisors; 41 percent were blue-collar (including craftsmen and technicians) and clerical workers; and one percent (one respondent) was a rancher.

People in Sheridan were about evenly divided in their responses to the statement "from your standpoint, job opportunities are good at the present time;" 37 percent agreed, 47 percent disagreed, 13 percent were neutral, and 3 percent responded "don't know."

To the statement, "Everything considered, I believe that approval should be granted to expand the Decker Mine," 55 percent of the blue-collar and clerical workers responded "yes," and more than 32 percent said "I need to know more about the expansion plans and likely consequences." This compares with 52 percent of the total sample who responded "yes" and 35 percent who said "I need to know more ***" Forty-six percent of the professionals voted "yes," and 32 percent said "I need to know more ***" Somewhat surprisingly, 57 percent of those who are retired voted "yes" and 32 percent said "I need to know more ***"

(2) The elderly

There are some interesting discrepancies in the responses of elderly persons. For example, those listing no employer (85 percent of whom are retired) were equally divided between agreement and disagreement with the statement that Sheridan can handle the increased population projected for expansion of the mine. The same group was equally divided in choosing between "economically beneficial" and "increased rents and living costs" as the principal effect the Decker Coal Co. proposals would have on Sheridan. Yet 57 percent of the smaller group representing only the retired voted "yes" to mine expansions.

(3) Miners

Most of the respondents to the survey who were miners worked at Decker. Thirty percent of them had lived in Sheridan less than one year; 10 percent had been a resident for one to five years; 20 percent had been a resident for five to ten years; and 40 percent much or all of their lives. Most of them owned their own homes although more lived in mobile-home courts (10 percent) than the total survey population (four percent).[1] More of them (20 percent) felt that local business gains and present taxes were sufficient to pay service costs related to Decker workers; only 11 percent of all those surveyed agreed with that choice. However, the rest of the miners surveyed were equally divided in how such costs should be paid; 40 percent chose "States of Montana and Wyoming should help ***" and 40 percent chose "coal industry and the two States should help ***"

(4) Other Sheridan residents

Most of the survey respondents who worked at clerical jobs had lived in Sheridan much or all of their lives; 40 percent of them worked for government, a number of these at the Veterans Administration Hospital.

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[1] A large mobile-home park a few miles outside the city was not surveyed.

Professionals, managers, and supervisors had more often moved to Sheridan in the past ten years, and more than one-third of them were self-employed.

(5) Montana ranchers living near the proposed Decker mines.[1]

Those who generally expressed doubt that most ranchers can continue operating without some outside source of income were in this category themselves. For them, coal leasing is one means of remaining in the ranching business. Respondents said that one thing ranchers most despise is owing anyone money, and perhaps the money guaranteed each year from coal leases is a means of making a rancher feel less dependent on short-term operating loans.

Community relations are not as strong in the Decker and Kirby areas as in some other southeastern Montana ranching communities. In the Decker area, several ranch headquarters were wiped out in 1936 with construction of the Tongue River Reservoir. This caused many of the old established families to leave. Another reason given for the lack of community feeling was the size of ranches and, therefore, the distance between people. With more and more dependence on Sheridan and improved access to it, the people have been depending less and less on each other.

d. Quality of life and social values

Many of the people interviewed described themselves, quite matter-of-factly, as WASPs (White-Anglo-Saxon-Protestant) and described the atmosphere of Sheridan as WASPish. The middle-class majority have deep ties to the land, either having spent much of their lives on ranches or farms or having relatives who are landowners. As such, they are indeed conservative and inclined to resist change. Yet the businessmen among them view future community growth (i.e., change) as good for business--at least to the point where chain store competition might come in and threaten their survival. While certainly good for business, recent change has brought with it some social elements that give Sheridanites an unpleasant taste of what future social impacts might produce. The very rich--and Sheridan reportedly has some exceptionally wealthy people--simply do not want the town to change. The very poor and the working classes tend to welcome change, feeling that they need new opportunities too much to extensively worry about social impact.

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[1] 1/ Montana ranchers are discussed separately, and those in Wyoming are not, because the ranchers directly affected by the proposed mine expansions are all in Montana. Data about ranchers in the Decker area come from: Institute for Social Research (1974a and 1975).

Sheridan's retired people, about a fourth of the city's adult population, have not been particularly affected by community change thus far, mainly because property taxes are still low and their contacts with new people have been minimal.

While the local economic situation is generally thought as good, some aspects of it are problematic. Socioeconomic-impact-area ranchers and Sheridan businessmen find themselves unable to compete for unskilled help because of the wages paid by the Decker Coal Co. (the company pays better than $7.00 per hour). Given the rising occupational expectations and hopes that go with industrial expansion, it is understandable that, although jobs are usually available for adults, the better paying jobs seem to elude many job seekers.

It is widely believed in Sheridan that the Decker Coal Co. tends to bring in outsiders for its better paying jobs, leaving the less attractive jobs for the locals. About 40 percent of the newcomers sampled in the city of Sheridan (i.e., people who have been in the city for less than one year) work for the Decker Coal Co. This is partly why the elderly residents usually are aware of company workers and their effects on the community, an awareness which is ordinarily positive.

The general feeling among Sheridan residents is that the Decker Coal Co. has been economically beneficial to the town. An exception to this awareness is that some feel that people with high wages tend to drive up prices and, therefore, make it harder for the retired and other low- and fixed-income people to get along. Also, with regards to "the coal industry" and not to the Decker Coal Co. alone, several expressed apprehension that some control over local political decision-making processes is already being exercised by industry through its ability to influence the votes of workers.

There was much resentment among the several Decker Coal Co. and railroad workers interviewed concerning having to pay Montana State income tax "for nothing." To them, the situation is a case of taxation without representation. In addition, such individuals felt that they are not even getting public services for their money. Not surprisingly, therefore, about three-quarters of the respondents thought that Montana should help pay part of Sheridan's public-service bill.

e. Social services and public facilities

(1) Housing

There is almost no housing available in Rosebud County, Montana, south of the Northern Cheyenne Reservation, the only part of Rosebud County which might be affected by the proposed Decker mines. A few landowners have allowed one mobile home on their property, but there are no mobile-home parks or housing developments in this area and no small towns that provide housing for the miners.

The southern section of Big Horn County is much like the southern part of Rosebud County. There are essentially no housing, shopping, or community services. There have been no announced plans to build either mobile-home parks or housing developments in Big Horn County. The county will not be able to provide significant housing for newcomers.

Demand for housing in the city of Sheridan has experienced a sharp increase over the past three years, increasing the costs and reducing adequacy and availability of housing to rent or buy. More than 80 percent of those in the study area disagreed with the statement that good housing is available in Sheridan. More than 70 percent said that rents are higher than two years ago, most of these reporting "much higher." From a list of seven items describing the most significant factors in community change in the past three years, 55 percent chose "housing costs." A social service official reported that his low-income clients have been virtually priced out of the market for even marginal housing for which workers with higher incomes are willing to pay extraordinarily high rents.

Except for a few apartments, most housing construction has been single residences costing around $50,000 (1975 dollars). The population increase was attributed to a combination of events: (1) A national trend to "escape" to small towns, (2) job seekers responding to publicity about coal-related development around Sheridan, (3) workers from coal-related developments such as those at Gillette settling their families in Sheridan where living conditions are more desireable, and (4) present activity at the West Decker mine. Responding to "What has been the principal effect of the Decker Coal Co. on Sheridan?," the greatest number (37 percent) chose "increased rents and living costs." A close second choice (34 percent) was "economically beneficial."

Most residents of Sheridan own their single-family homes. Among these are some older people who expressed a wish to sell their property while they can get a good price, if only there were available apartments or mobile-home parks especially designed for older residents. In the summer of 1975, a yet to be completed retirement facility in Sheridan had already rented all of the proposed units to the project's investors.

The existing mobile-home parks in and around Sheridan have almost no vacancies. Two new mobile-home parks are under construction with a combined capacity of 125 units. County and city restrictions on mobile-home courts are stringent regarding water, utility hookups, and pavement. A slow development of mobile-home parks can be expected to continue.

(2) Water and Sewage

In Sheridan County, the city of Sheridan has adequate water rights, five million gallons per day. This water volume is supplemented by storage capacity of 590 million gallons. The water distribution system is divided between two storage areas, a north reservoir and a south reservoir. This division aggravates distribution problems which result in minimally adequate service. Some reduction of water pressure has been noted in the area supplied by the north reservoir.

Sheridan presently has sewage treatment capacity of 2.1 million gallons per day. Applying the standards used by the Wyoming State Engineer's Office of 168 gallons per day per person, the present system is adequate for approximately 12,500 people. Given the present estimated population of 13,000 in Sheridan, the treatment capacity is inadequate. The limiting factor in the sewage-treatment design is the sewage-collection system which is presently overloaded in some sections.

(3) Transportation

One airline provides daily north and south flights through Sheridan from Denver and Billings. Two private companies provide charter flights and air-ambulance service.

Many county roads and city streets in Sheridan County need improvement; however, maintenance in the past has been adequate. Complete daily bus service is available to Sheridan.

Amtrak train service (three trains weekly east and west) and daily east-west bus service provide Forsyth, Montana with adequate surface transportation. A commuter bus provides daily service between Forsyth and Colstrip, Montana. Major air service is provided at the Billings airport.

State Route 315 from Colstrip to I-94 needs to be rebuilt. This route handles all road traffic into and out of Colstrip.

Hardin, Montana is served by a daily bus running between Sheridan and Billings. Billings serves as a transportation center for Big Horn County. In general, Big Horn County roads need improvement; however, the State route from Decker to Highway I-90 in Wyoming is in fairly good condition. The Montana State Highway Department is presently conducting a survey of highway needs in the entire coal-development area of southeastern Montana.

(4) Schools

Sheridan County is divided into three school districts. Almost all of the growth in Sheridan County has taken place in School Disctrict #2, which includes the city of Sheridan and vicinity.

The ten public schools in School District #2 include seven schools housing grades K-6, one school housing grades K-8, one junior-high school housing grades 7 and 8, and one senior-high school housing grades 9-12. During the 1974-1975 school year, these schools served 3,216 students. Four of the schools operated during the 1974-1975 school year at or above capacity.

The Superintendent of School District #2 estimated that the district is capable of handling an additional 300 students, approximately half at the secondary level and half at the elementary level. The additional elementary children would have to be bused to equalize school loads. Busing to equalize school loads is presently done and is an unpopular practice.

The quality of the school buildings in School District #2 varies considerably. Several schools require extensive repairs and remodeling.

Given the expectation that expansion at Decker would bring over 1,000 new people to the Sheridan area, School District #2 should now be in the position of preparing to expand school facilities. However, the district has only approximately $260,000 in bonding capacity remaining and will not have an increased bonding capacity in the foreseeable future.

The Institute's survey indicated general satisfaction with School District #2's schools; 72 percent said they were satisfied with the grade schools, 62 percent with the high school.

School District #1 (Wyoming), which includes the communities of Big Horn, Dayton, and Ranchester, has a total enrollment of 627. The Superintendent estimated that the Big Horn elementary school could handle only 15 to 20 additional students. Both Sheridan City high schools are at their capacity enrollment. A bond issue for an elementary/junior high at Ranchester is in the planning stages.

School District #3 (Wyoming), which serves Clearmont and Arvada, has a total enrollment of 109. There are 45 in the high school, 20 in the junior high, and 44 in the elementary school. The Superintendent estimated that the present total enrollment could be doubled without additional facilities.

The eight elementary and three high schools in Rosebud County are in reasonably good condition. In Colstrip, schools have experienced serious crowding and are therefore inadequate. Seventeen instructional spaces are in use to alleviate some of the crowding. A new elementary school and additions to the high school in Colstrip were approved by voters in October, 1975.

Big Horn County has a complicated assortment of school districts serving communities on the Crow Reservation and the rest of the county. Although the unification of schools in Big Horn County would cause transportation problems, it would allow more diversity in school programs and improvement in instructional materials available. New facilities are particularly needed at Lodge Grass to accommodate the growing school age population. The town of Decker, Montana, has a small grade school with a capacity of about 20.

(5) Recreation

Sheridan has a YMCA, which offers a wide variety of recreational facilities and programs. Annual membership, which now costs $96 for a family membership and $25 for a high-school student, is, according to the survey, prohibitive for many families. The city provides a swimming pool, tennis courts, golf course, gymnasium, ice skating rinks, playgrounds, and a small zoo. There is easy access to good hunting and fishing. Seventy-four percent of the respondents expressed satisfaction with the recreational facilities.

Recreation facilities for the town of Hardin in Big Horn County and Forsyth and Colstrip in Rosebud County, Montana, are described in Appendix G. Both of these counties have limited recreation opportunities aside from fishing and hunting. A discussion of the recreational facilities and activities in the area of the proposed Decker mines is given in section II. C. 7.

(6) Public safety

The city of Sheridan is served by a 21-member police department. The sheriff's department has six full-time officers. Given a population in Sheridan of approximately 13,000 and in the county outside of Sheridan of 6,300, the city police should have 26 members and the sheriff's department should have 13 members.[1/]

Over the years, Sheridan residents have come to expect the police department to provide a variety of helping services in addition to law enforcement. As a result the relationship between police officers and townspeople has been friendly, cordial, and informal. Recently the influx of many job seekers who cannot be counted on to treat policemen as friends and neighbors has forced the police to become less trustful and more formal than they have been. As a result, many of the study's respondents felt that, although the police department recently hired four new men, it needs to add still more officers if it is to adequately meet present law enforcement demands. Accordingly, when only 56 percent of the respondents indicated that they were satisfied with police protection, the implied dissatisfaction was more with lack of numbers than lack of quality.

The county sheriff and other deputies are responsible for all of Big Horn County, excluding Indians on the Crow Reservation, but including whites on the reservation. Indian police have responsibility for tribal members on the reservation. A seven-man police force serves Hardin. This force is equipped with two cars and handles only minor problems. Given equipment shortages and division of responsibility, law enforcement coverage in Big Horn County is not adequate.

[1/] This adequacy standard of one officer per 500 population is derived from the national and Wyoming averages as cited in "Capital Facilities Study: Powder River Basin," by Intermountain Planners and Wirth-Berger Associates; prepared for the Wyoming Department of Economic Planning and Development, April 1, 1974.

Rosebud County is served by a 15-man, combined city-county law enforcement department. Ten men are assigned to Forsyth, two to Colstrip, two to Ashland, and one to Birney. Population estimates suggest that the county falls short of meeting national adequacy standards of one officer per 500 residents. Two highway patrolmen operate in Rosebud County.

(7) Fire protection

A 16-man full-time fire department serves the city of Sheridan. The department is adequately equipped with three trucks that have pumps of 750 gal/min capacity or greater. A potential problem, however, lies in the annexation of areas which have inadequate waterlines.

Sheridan County has a four-man force at the airport, providing 24-hour onduty service. The force has three trucks with pumping capacities of 500, 750, and 1,900 gal/min. In addition, each of the county's 12 fire zones has a four-by-four truck with 275 gallons of water for fighting prairie fires.

The Sheridan VA Hospital has its own fire department and equipment.

In Rosebud County, fire protection is presently adequate for Forsyth and Colstrip. Currently, the sheriff's department is responsible for providing a volunteer force to fight rural fires, Rural fire protection could be stronger if an organized force existed.

The rural areas in Big Horn County are served by volunteer firemen consisting of sheriff's deputies and employees of the County Roads and Bridge Department. Hardin has one new fire truck and one backup truck. The county has two trucks, each having 1,000 gallon tank capacity. Lodge Grass and Decker each have an army surplus six-by-six truck with a tank and pump.

(8) Welfare and social services

A staff of nine operates the Welfare Department in Sheridan. Two hundred fifty persons receive Social Security incremental payments, a larger number than normal for a community the size of Sheridan. This load may be attributed to the larger-than-average population of elderly residents. The Sheridan Welfare Department considers other caseloads normal for a community the size of Sheridan.

The Sheridan County Welfare Department has very limited outreach capabilities. The YMCA has a wide variety of programs for both the elderly and the young. There is also a Meals-on-Wheels Program operated by volunteers and a senior citizens' bus.

A Youth Services Project, which is funded by a Law Enforcement Assistance Administration grant, provides an information service, family counseling, and a job opportunties program. Counseling services are available from the Mental Health Center. Also, there is an extensive alcoholism program for veterans and Indians at the local VA Hospital.

Five staff members serve the combined Rosebud County and Treasure County Welfare Department located in Forsyth. Assistance payments have continued at the same level for several years and possibly will not increase as the population grows and job opportunities expand. The department provides home visits by a professional homemaker to the elderly, disabled, and blind. The only youth services are available from the mental health outreach workers and the local drug and alcoholism programs.

The Big Horn County Welfare Department is operated by a seven-member staff, including two social workers and one full-time and one part-time homemaker. The department handles all categories of welfare in the county and all categories except general assistance and child welfare on the Crow Reservation. These two programs are handled by the Bureau of Indian Affairs Welfare Office. The Big Horn County welfare staff reports spending much of its time on Indian-related work.

The department feels that a need exists for outreach programs for senior citizens and youth, but no funding is available. Other welfare services are adequate.

(9) Health services

(a) Health care personnel[1/]

Sheridan has 21 physicians, including such specialists as a pathologist, a radiologist, and pediatricians. There are approximately 60 registered nurses at the Sheridan hospital, and the hospital has complete laboratory facilities. The number of physicians exceeds the adequacy standard for Sheridan County. The number of health care personnel are at present (summer 1975) adequate for Sheridan's role as a regional medical center.

While over 80 percent of Sheridan's residents indicated that they are satisfied with the city's medical and dental services, some who are generally satisfied go to Billings (especially to the Billings Clinic) for the services of specialists, and those who are not satisfied usually go to Billings for all of their health care. There is a little less satisfaction (a little over 70 percent) with Sheridan's hospital. Several respondents who claimed to be particularly well informed about the situation said that the turnover

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[1/] The discussion about health services does not include any VA service or personnel.

among young doctors is related to frustration with the hospital personnel--and with the older doctors who typically fail to rally to their support. Some people believe that too many of the younger doctors who stay in town only a short time are attracted more by money than the opportunity to serve mankind.

Respondents generally reported that health care for the elderly was inadequate. They pointed to the need for retirement facilities which would offer health services to residents who are still essentially able to care for themselves.

The rapidly rising cost of health care in Sheridan was thought to be unrelated to coal development.

In Rosebud County, one physician practices in Forsyth. A nurse practitioner operates in a clinic office in Colstrip where a doctor is available one day a week. Ashland has a similar clinic. One Public Health nurse serves all of Rosebud County. The county's greatest health care need is for skilled nurses and physicians, especially physicians. Many patients currently prefer to travel to Miles City, Billings, or Sheridan, Wyoming, for treatment of minor ailments. Using the standard of one physician per 1,222 persons, Rosebud County should have at least five more physicians. Some improvement in Rosebud County's medical situation is expected in 1976, as three new physicians have recently been recruited. At least one more Public Health nurse is also needed for the county.

In Big Horn County, one physician and one physician's assistant serve the hospital in Hardin. The Indian Health Service operates an out-patient clinic at Lame Deer on the Northern Cheyenne Reservation. The Northern Cheyenne tribe expects to construct a million-dollar clinic building in the near future.

An Indian Health Service hospital at Crow Agency on the Crow Reservation serves both reservations. There are two Indian Health Service physicians, three nurses, and one physician's assistant at Lame Deer and Crow Agency. The physicians have historically left after completing their two-year commitment to the Indian Health Service. Presently non-Indian residents on the reservations go to Billings or Sheridan.

Using the above-mentioned standard for physicians, Big Horn County needs five or six more physicians to provide adequate medical service in the county.

(b) Hospitals and ambulances

The 89-bed Sheridan hospital, the best staffed in the study area, has a coronary care unit as well as surgical, obstetrical, pathological, and radiological services.

Using the standard of four hospital beds per 1,000 people,[1/] the hospital facilities are more than adequate for the population of Sheridan County.

Approximately 30 percent of the patients using the Sheridan hospital live outside of Sheridan County. The size of this group indicates that changes in population in surrounding counties, particularly Campbell County,

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[1/] The adequacy standard of four beds per 1,000 population is based on the national average of 1,183 patient days per 1,000 of population multiplied by roughly 82 percent average occupancy rate for each hospital. These figures lead to a projected need of four hospital beds per 1,000 population in each county.

will have a significant impact on the Sheridan hospital. The 89 beds are adequate for a population of approximately 22,200 using the standard of four beds per 1,000 population. This figure exceeds the present population of Sheridan County.

A new 26-bed hospital serving Hardin and the non-Indian population of Big Horn County includes coronary care, surgery, and obstetrical units and is well equipped for its size. Indians from the Crow Reservation must use the Indian Health Service hospital at Crow Agency if they are receiving federally-financed medical care.

Again, the factor limiting health care is not the hospital, but the number of physicians and nurses.

Two Sheridan funeral homes provide Sheridan County with two ambulances and a backup vehicle. These units also serve Decker and Birney in Montana. The ambulance operators have some training in first-aid procedures, but emergency medical services are not their primary daily concern.

Ambulance service for the northern part of Rosebud County is provided by one county-owned ambulance which lacks respiratory equipment. Western Energy Company has an ambulance for Colstrip.

The Indian Health Service provides ambulance service for the Northern Cheyenne Reservation. Rosebud residents living south of the reservation depend on the two ambulances in Sheridan.

Two ambulances, which are operated by three, well-trained and salaried staff, provide good ambulance service for Big Horn County.

(c) Nursing-retirement homes

A 96-bed nursing home and extended-care facility serves Sheridan and the surrounding counties. A retirement home planned for 120 persons will cost a minimum of $200 per month for an efficiency apartment and $75 or $80 per month for required meals. This home has not yet been financed, but there is already a waiting list.

In the past, the elderly (16 percent of the Sheridan County population was 65 or older) have been able to find reasonably priced housing in Sheridan; in fact, most of them live in their own homes.

A 39-bed nursing wing is attached to the hospital at Forsyth. For the present, this facility is meeting the needs of the elderly in Rosebud County.

A 34-bed, county-supported nursing home is connected to the hospital at Hardin. A 22-bed nursing home provides services for elderly needing less intensive attention. Both facilities have very short waiting lists and are considered adequate to meet present demands.

(d) Mental health facilities

The Northeast Wyoming Mental Health Organization in Sheridan serves a five-county area of northern Wyoming. The Mental Health Center has a full-time staff which offers comprehensive services which are about average for Wyoming communities. The center seems to have emerged as the leader and coordinator of the area's mental health service programs, but funding was reported to be tenuous and subject to future fluctuation.

The Eastern Montana Mental Health Center, which serves an 18-county area from its headquarters in Miles City, provides one full-time counselor in Forsyth to serve Rosebud County.

The South Central Montana Mental Health District has two staff members in Hardin. Heavy caseloads limit outreach mainly to school-related problems.

6. Archaeological and historical sites

Early archaeological studies of the proposed mine areas are included in reports by Loendorf, et al. (1972) and by Haberman (1973). During the summer of 1975, and archaeological survey was completed for the proposed East Decker and North Extension project areas by the Mineral Research Center of the Montana College of Mineral Science and Technology Foundation (Fredlund, 1976). During the summer of 1976, an archaeological surface reconnaissance of the two project areas was made by Anthropologos Researches International, Inc., (Larry Lahren, written communication, November 3, 1976, and December 3, 1976).

a. Archaeological survey of 1975 and associated testing of the proposed mine areas

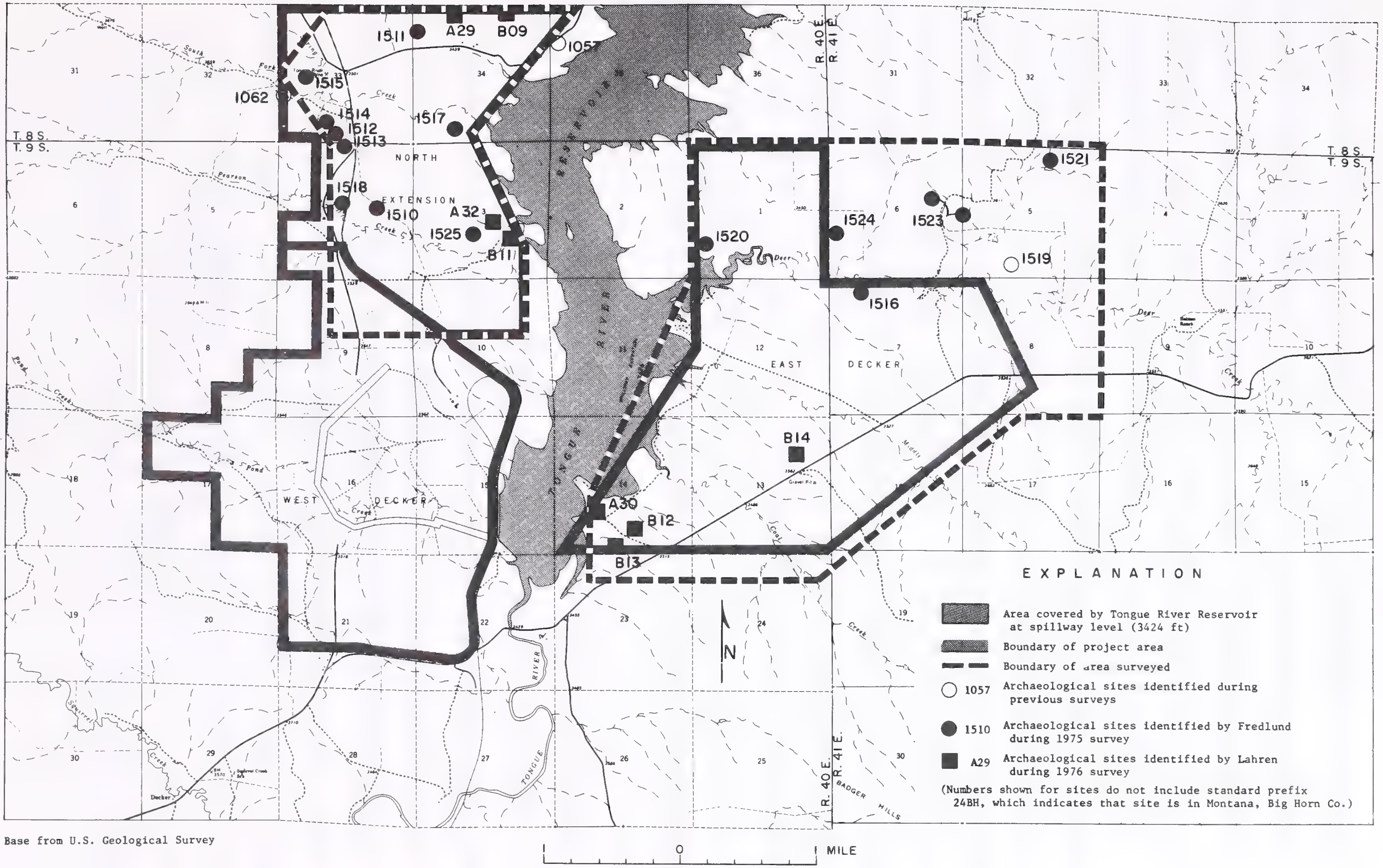
Fredlund, under contract to the Decker Coal Co. located and recorded 15 archaeological sites in the East Decker and North Extension survey areas[1/] (table 33A and fig. 63). These sites included three lookout sites, five occupation sites, one tipi ring, one rock structure whose function is unknown, one quarry workshop, one rock cairn, and three diverse activity sites.[2/] A complete description and analysis of these sites is given in Appendix H.

[1/] The "survey area," as defined by Fredlund (1976), is somewhat larger than and includes the project areas outlined in this impact statement. Of the 15 sites located and recorded by the Mineral Research Center, 12 are within the project areas (fig. 63).

[2/] The draft environmental impact statement utilized Fredlund's (1975) preliminary archaeological report for the proposed mine areas. The preliminary report was incomplete in that data from laboratory analyses and literature review were lacking, portions of the North Extension mine area had not been surveyed, and no recommendations were made as to what further work was needed to adequately evaluate each of the sites identified. Fredlund's final report (Appendix H), which is summarized herein, corrects those deficiences.

Table 33A.--Archaeological sites and selected attributes for the East Decker and North Extension areas as identified by Fredlund (1976)

Site number and name	Location	Site type	Site area (meters)	Distance to water	Ecological association	Artifacts & features
24BH1510 Three Deer tipi rings	NE¼SE¼ sec. 4 T. 9 S., R. 40 E.	Occupation	100 x 300	100 (seasonal)	Rolling grassland	1 biface preform 1 biface end fragment 5 stone rings
24BH1511 All Gone site	NW¼NW¼ sec. 34 T. 9 S., R. 40 E.	Occupation (limited activity)	30 x 50	1,000 (seasonal)	Ridge-juniper	3 end scrapers, 2 cores 3 bifaces, 1 perform
24BH1512 Fat Albert site	SE¼SW¼ sec. 33 T. 8 S., R 40 E.	Lookout	100 x 100	330 (seasonal)	Ridge-juniper	----
24BH1513 Puppy site	SW¼SW¼ sec. 33 T. 8 S., R. 40 E.	Lookout	600 x 600	330 (seasonal)	Rolling grassland	----
24BH1514 Knoll site	NE¼SW¼ sec. 33 T. 8 S., R. 40 E.	Lookout	600 x 600	330 (seasonal)	Rolling grassland	----
24BH1515 Lost & Found site	SW¼NW¼ sec. 33 T. 8 S., R. 40 E.	Lookout/ Occupation	50 x 100	250 (seasonal)	Rolling grassland	1 end scraper 1 biface
24BH1516 Darby site	NE¼NW¼ sec. 7 T. 9 S., R. 41 E.	Limited activity	5 x 5	10 (seasonal)	Ridge-juniper	1 perforator
24BH1517 Yellow Patch site	E½SW¼ sec. 34 T. 8 S., R. 40 E.	Occupation	40 x 75	330 (seasonal)	Grassy ridge	3 biface preforms, 1 biface, 1 point, 1 end scraper
24BH1518 Juniper site	SE¼SE¼NW¼ sec. 4 T. 9 S., R. 40 E.	Occupation	10 x 30	250 (seasonal)	Grassy ridge	1 corner-notched point
24BH1519 Sonnemaker complex	SE¼SW¼ sec. 5 T. 9 S., R. 41 E.	Varied activities	50 x 500	250 (seasonal)	Ridge	1 corner-notched point, 1 biface fragment
24BH1520 Deer Creek rock structure	SE¼SW¼ sec. 1 T. 9 S., R. 40 E.	Rock structure	----	30	Rolling grassland	2 rock structures
24BH1521 Bad Water site	NW¼SW¼ sec. 5 T. 9 S., R. 41 E.	Occupation	6 x 8	500 (seasonal)	Ridge-juniper	1 graver, 1 spokeshave, 1 hematite object
24HB1523 LSA Factory site	NW¼SW¼ sec. 5 R. 9 S., R. 41 E.	Quarry workshop	100 x 500	1,000	Ridge	----
24BH1524 Scobie site	NW¼SW¼ sec. 6 T. 9 S., R. 41 E.	Occupation	15 x 100	300	Ridge	1 point, 1 biface, 1 point fragment Eroded hearth
24BH1525 Channel rock piles	NE¼SW¼ sec. 3 T. 9 S., R. 40 E.	Rock cairns	100	----	Ridge-grassland	Line of rock cairns


EXPLANATION
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of project area
Boundary of area surveyed
1057 Archaeological sites identified during previous surveys
1510 Archaeological sites identified by Fredlund during 1975 survey
A29 Archaeological sites identified by Lahren during 1976 survey
(Numbers shown for sites do not include standard prefix 24BH, which indicates that site is in Montana, Big Horn Co.)
1511
A29
B09
1057
1062
1515
1514
1512
1513
1517
1518
1510
A32
1525
B11
NORTH
EXTENSION
1520
1524
1523
1521
1519
1516
EAST
DECKER
B14
A30
B12
B13
WEST
DECKER
RESERVOIR
TONGUE
RIVER
T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
N
0
MILE
BADGER HILLS
South Fork
Pearson
Creek
Deer
Pond
Coal
Middle
Squirrel
Decker

Base from U.S. Geological Survey

Figure 63.—Archaeological sites in the East Decker and North Extension areas.

Sites identified were located near sandstone outcrops on ridges or on broken scoria outcrops within or adjacent to juniper breaks that offered some protection from the elements. No sites were found on open grasslands or at lower elevations. Most sites were located on south-facing slopes.

Sites composed of rock included rock rings, rock piles, and rock structures. The only rock ring site identified (24BH1510) contained remnants of five stone circles. These rock rings are fairly common throughout the Northern Great Plains and are generally interpreted as circles left from rocks placed to hold down the outer edges of skin tipis. Four of the five circles in site 24BH1510 contained several rocks grouped together near the center of the rings. These interior rocks are thought to be related to fire hearths.

Rock piles were noted throughout the surveyed lands but were not given site numbers unless they were associated with lithic debris or other identifiable features.

The third type of rock associated site were two structures (25BH1520) located just north of Deer Creek (fig. 63). One of the structures was clearly historic but the other appeared to be considerably older and possibly could have been an aberrant type of vision-quest structure.

Sites identified by flakes range from a few small scattered flakes covering a few square meters to numerous flakes covering as much as 100 meters in length. Some sites (e.g., 24BH1514) consist largely of flakes with very few tools; these may have been chipping stations or places where a hunter stopped to watch for game movement on the grasslands below and engaged in tool fabrication while he waited. Other sites appear to have had specific associated activities. For example, sites 24BH1516 and 25BH1511 had very few flakes or lithic detritus in relation to the number of tools. This suggests that chipping or sharpening of tools did not occur at the site and that perhaps another activity such as hide preparation or clothing repair was the primary activity.

The last type of site identified by the survey was a quarry (24BH1523) located on an outcrop of nonvolcanic natural glass (clinker). Nonvolcanic natural glass is often found at occupation sites of prehistoric inhabitants and is a common rock type in the Decker area.

Only one site (24BH1524), which contained fire-discolored rock exposed by erosion, required detailed examination. This site was systematically collected, and the area in the vicinity of the exposed hearth was examined by systematic troweling. These efforts confirmed the shallowness of the deposit and indicate that surface collection would almost totally recover all cultural material at this site.

The time period for most of the occupations identified in the Decker survey areas appears to be late prehistoric because of the small corner or side-notched points occasionally found on some sites. A corner-notched point of a late middle period was found at one site. Although no evidence of activity before 500 B.C. was found within the two proposed mine areas, a number of other sites in south-central Montana indicate that people lived in the area at least 10,000 years ago.

b. Archaeological surface reconnaissance of 1976 in the proposed mine areas

Larry Lahren, under contract to the U.S. Geological Survey, evaluated the impacts of coal development on the cultural resources of the Northern Powder

River Basin (Larry Lahren, written communication, December 3, 1976). That evaluation included an archaeological surface reconnaissance of the proposed Decker mine areas. Lahren surveyed all the North Extension mine area, but was denied access to all but secs. 13 and 14 T. 9 S., R. 40 E. in the East Decker area.

In addition to those sites identified by the Mineral Research Center, Lahren located the following sites within the project areas (table 33B and fig. 63): Five ridgecrest prehistoric habitation sites, two stream-terrace prehistoric open-camp sites, a network of stone lines (possibly leading to a bison kill), rock cairns, and stone circles. Lahren's contract with the U.S. Geological Survey required only that cultural sites be identified and that appropriate recommendations regarding the testing, collection, or preservation of such sites be made. Accordingly, the only available information for sites identified by Lahren is listed in table 33B and in the section on mitigation of impacts to archaeological sites (VI. C. 6.).

c. History

The history of the Decker area is described by Murray (1973, 1975) of Western Interpretive Services. Murray, under contract to the Decker Coal Co., attempted to identify significant historical events that occurred within the study area and to determine whether any sites or structures related to such events remained. Structures within the study area were evaluated to determine if they had architectural value either as individual works or as representative specimens of distinctive types of regional architecture.

(1) Brief historical account of the Decker area

The Decker area lies in a locale that has been a rather quiet "backwater" of human activity for much of the recorded past. Geographic opportunities and

Table 33B.--Additional archaeological sites identified in the East Decker and North Extension areas by Lahren[1]

Site number	Location	Site type	Artifacts[2]
24BHB09	NE¼NW¼NE¼ sec. 34 T. 8 S., R. 40 E.	Ridgecrest habitation	1 brown chalcedony biface fragment.[3]
24BHA29	NW¼NE¼NW¼ sec. 34 T. 8 S., R. 40 E.	Ridgecrest habitation	--
24BHA32	NW¼NW¼SE¼ sec. 3 T. 9 S., R. 40 E.	Ridgecrest habitation	1 gray porcelainite biface fragment.[3] Few gray, black, and red porcelainite flakes.
24BHB11	SE¼NW¼SE¼ sec. 3 T. 9 S., R. 40 E.	Stream terrace open camp	1 gray chert flake. Few gray and red porcelainite flakes.
24BHB12	NW¼SW¼SE¼ sec. 14 T. 9 S., R. 40 E.	Ridgecrest habitation	Few gray and red porcelainite flakes.
24BHB13	SE¼SE¼SW¼ sec. 14 T. 9 S., R. 40 E.	Ridgecrest habitation	1 white quartzite flakes. 1 red nonvolcanic glass flake.
24BHB14	NE¼ sec. 13 T. 9 S., R. 40 E.	Drive lines rock cairns	Drive lines (possible buffalo kill). Rock cairns, stone circles.
24BHA30	W½NE¼SW¼ sec. 14 T. 9 S., R. 40 E.	Stream terrace open camp	1 gray chert flake. 1 red quartzite nodule. 1 black chert flake. 2 gray nonvolcanic glass flakes. 2 red nonvolcanic glass flakes. Numerous red and and gray porcelainite flakes. 1 red nonvolcanic glass projectile point fragment. 1 gray porcelainite projectile point fragment.[3] 1 gray biface fragment.

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[1] Larry Lahren, written communication, December 3, 1976.

[2] Artifacts were only observed unless otherwise noted.

[3] Artifact was collected.

constraints were such that the main routes of exploration, trade, and development bypassed the region. Until the beginning of actual white settlement in the Decker area, only occasional white parties passed this way.

The earliest written record of travel through the study area is that of Charles LeRaye, who claims to have visited the region during the summer of 1802 in the company of a group of traders and Crow and Hidatsa Indians. From August 12-25, the party camped a short distance downstream from the present Tongue River Dam. On August 25, they moved through the study area and camped at the mouth of Goose Creek, passing through the Decker area without incident. Other early journalists in the region, such as Francois Antoine Larcoque (1805) and Wilson Price Hunt (1811) missed the study area by many miles.

The earliest parties engaged in surveying and mapping the region were those of Captain William F. Raynolds and Lieutenant Henry Maynadier in 1859-1860. They, too, skirted the area by a wide margin.

Active emigrant and military travel in southeastern Montana accelerated after 1863, when John Bozeman of the Montana Gold Mining Company publicized a trail formed by linking older trails noted by Raynolds, Maynadier, Larcoque, and LeRaye. Civilian and military travel on the Bozeman Trail brought that route national publicity, and because of its easy gradient, the trail became the most commonly traveled route from southeast to northwest through southeastern Montana. The Bozeman Trail did not traverse any part of the Decker area.

The main course of action in the Indian Wars of the region from 1865-1877 also completed bypassed this area, and the only military party of note to travel through the region was Brigadier General George Crook's column enroute from a base camp on Little Goose Creek to a junction with the forces of General Alfred Terry. Crook's force of about 1,500 men camped on the night of August 5, 1877 at the mouth of Prairie Dog Creek and marched through the Decker area the next day. They evidently followed the river bottom northeastward because they reported crossing the Tongue River 13 times in one day. Crook's forces did not camp within the Decker area.

Occasional military parties in the post-Indian War days of 1878-1894 passed through the region, but they generally functioned only as messengers between Fort McKinney and Fort Keogh. The army reconnoitered two wagon routes between these posts. One was east of the Tongue River; the other crossed into Rosebud Creek valley and followed that stream to its mouth. Neither route was every used by a military wagon train, insofar as can be determined.

Throughout the early history of ranching settlement in the region, the study area remained "in the back country." The Rock Creek Stage Co. was the main transportation line through the region, but it bypassed the Decker area. Travel through the Decker area, therefore, was limited largely to ranchers going to and from Sheridan.

While other portions of the Tongue River Valley played an important role in the development of the cattle industry in Montana and the Dakotas, the Decker area itself did not. In 1880, the OD Ranch located their headquarters near the confluence of Corral and Rosebud Creeks northwest of Decker. In 1887, the OW Ranch, the forerunner of the Kendrick Cattle Co., established headquarters in the Hanging Woman Creek drainage approximately 10 air-miles east of Decker. Both ranches were large open-range operations that utilized at least part of the Decker area, and therefore, probably precluded any significant development of other large cattle operations in this general area. The Northern Cheyenne Reservation to the north and the Crow Reservation to the west probably were also deterents to the development of a large ranching operation in the Decker area.

Homesteading expanded in the Decker area coincident with the rise in wheat prices during World War I. Most structures within the study area date from that period or were constructed after 1920.

(2) Structures

The oldest identified structure in the Decker area is at the headquarters of the Holmes Ranch in the SW¼NE¼ sec. 9, T. 9 S., R. 41 E., about 1.5 miles east of the East Decker mine area. This small building, which lies adjacent to the main house, has doors, window casings, hardwood, etc. that indicate the structure was probably the oldest structure in the Decker area, this building has no historic value and is not architectually significant.

Other structures in the Decker area are a barn and some ruins and foundations lying about half a mile northeast of the structure described above. These ruins and foundations reportedly date from a cattle operation in the Decker area that preceded the homestead period. The barn, however, does not appear to be that old.

Other structures and remnants of habitation in the Decker area include a small shingled house and ruins of a stone barn lying between the West Decker mine and the Tongue River Reservoir in the SW¼NW¼ sec. 15, T. 9 S., R. 40 E. These appear to have no historical or architectural significance.

The old Tongue River coal mine lies within the North Extension area (see p. 55). The mine is typical of small coal mines in the area and was not a significant producer of coal in comparison to other mines closer to Sheridan. The old Tongue River mine contains no historic or architecturally significant structures.

South of the existing West Decker mine in the SE¼SW¼ sec. 21, T. 9 S., R. 40 W., are a cluster of commercial and residential buildings. Most of these structures are less than 40 years old, and collectively, they constitute a marginal series of commercial ventures of no particular historic significance.

In addition to those structures discussed by Murray (1975), a group of foundations and ruins adjacent to the east shoreline of the Tongue River Reservoir in the SW¼NW¼ sec. 14, T. 9 S., R. 40 W. have been identified (Larry Lahren, written communication, December 3, 1976). These structures may have no historical or architectural signficance; however, they should be photographed, described and verified before a final determination can be made.

7. Recreation facilities and activities in the Decker area

Because of the rural nature of the area, most recreation facilities and activities in the Decker locale are oriented towards outdoor-type enterprises. The Tongue River Reservoir is the principal recreational attraction. The Montana Club, near the West Decker mine, includes a bar and minimal restaurant accommodations and provides a social center for local ranchers and miners and for people traveling through the area.

The following paragraphs discuss the recreational use and the potential for future development of the Tongue River Reservoir, the Tongue River, and land areas adjacent to the proposed mines. Also included are the results of a creel census of reservoir fishermen. Public recreation facilities and activities in Sheridan, Wyoming, where most of the Decker mine employees live, are discussed in section II. C. 5.

a. Tongue River Reservoir and Recreation Area

The Tongue River Reservoir provides a diversity of activities, including camping, picnicking, boating, fishing, ice fishing, water skiing, and water fowl hunting. Residents of Big Horn, Rosebud, and Powder River Counties in Montana, Sheridan County in Wyoming, and often far more distant areas are frequent vistors to the reservoir.[1/]

Existing recreational facilities are located along the northwest and the extreme northeastern sides of the reservoir. They include latrines and shelters at two semideveloped campsites, two natural boat ramps, a vista area, and an access road (fig. 63A). Grills and garbage cans are located intermittently along the reservoir in areas where access is available. These existing facilities are generally in poor condition. Dispersed recreational use of the reservoir also occurs in those scattered areas where access is provided by unimproved roads (Dick Mayer, Montana Fish and Game Department, personal communication, January 17, 1977).

Two semideveloped sites provide the only established camping areas near the reservoir (fig. 63A). The Tongue River Recreation Area is on the northwest shore of the reservoir in the SE¼ sec. 26, T. 8 S., R. 40 E. The other camping area is adjacent to the Tongue River immediately downstream from the

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[1/] The Montana Fish and Game Commission (1974) reports that 20-25 percent of the recreationists in southeastern Montana are from out-of-state.

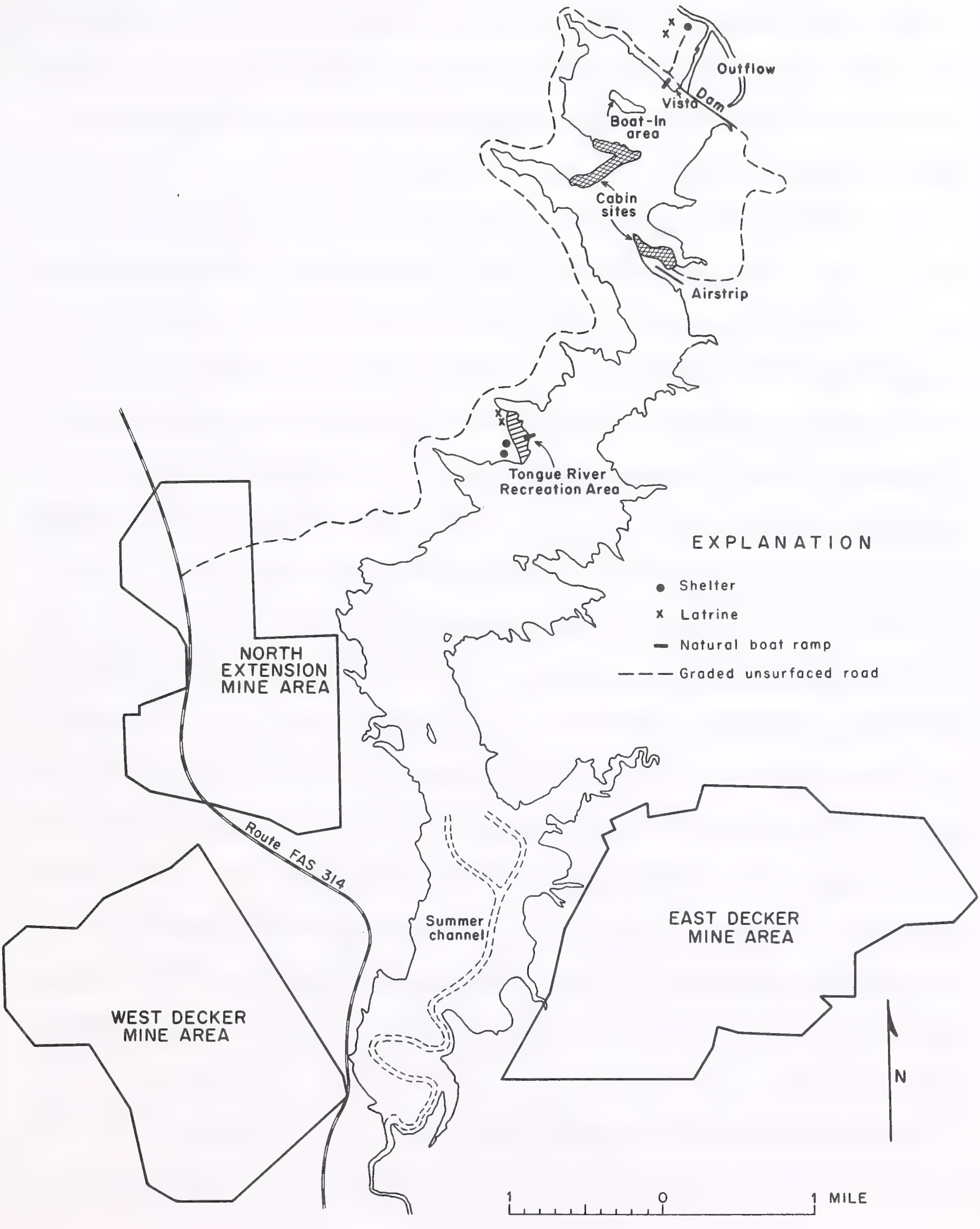

Figure 63A.—Map of the Tongue River Reservoir showing existing recreation facilities.

dam. Each camping facility has two latrines, which are maintained by a local citizen under contract with the Department of Natural Resources and Conservation, and at least one shelter (fig. 63A). Although these facilities are minimal, use to date has been sufficiently light that the existing facilities have generally been adequate.

The extreme southern end of the reservoir opposite the existing West Decker and the proposed East Decker mines receives very little recreational use. In the late summer this part of the reservoir normally becomes an extensive mud flat as reservoir drawdown occurs (figs. 47 and 63A).

Many of the partially submerged trees that died when the Tongue River Reservoir was established are still standing. Although these dead trees create hazardous boating and water-skiing conditions locally, these hazards do not seem to seriously inhibit recreational use of the reservoir.

b. Other facilities and activities

Considerable recreation potential for fishing, hunting, and floating exists along the Tongue River, both upstream and downstream from the reservoir. Recreational use of the river, however, is limited by a lack of designated access points (Montana Fish and Game Commission, 1974). During the fall months, hunters often float the river seeking deer, water fowl, and grouse on the wooded islands and bottomlands. A high potential for canoeing exists in the reach extending about 10 miles downstream from the Tongue River Reservoir where the river flows through scenic canyons and occasional wooded bottomlands.

Big game and upland game-bird hunting are major land-based recreational uses on the areas adjacent to the Tongue River Reservoir; however, hunting access is severely restricted because 80-95 percent of these lands are in private ownership. Other land-based recreational activities in the Decker area include pleasure driving, hiking, sightseeing, picnicking, motor-bike riding, and occasionally snow mobiling during the winter months (Montana Fish and Game Commission, 1974). Although the Decker area is not rich in historic sites, other parts of Big Horn and Rosebud Counties have sites that attract large numbers of tourists.

c. Creel census for the Tongue River Reservoir

A partial creel census that sampled anglers as they left the Tongue River Reservoir was conducted in 1975 and 1976 by the Montana Fish and Game Department (see Appendix F for a description of census methods). Shore fishermen dominated the sample in 1975, composing 53 percent of the total, whereas boat fishermen were dominant in 1976, composing 65 percent of the sample. For both years, boat fishermen spent more time actually fishing than shore fishermen, representing 72 percent of total fishermen hours in 1975 and 77 percent in 1976. Boat fishermen also caught more fish than shore fishermen; 66 and 80 percent of the total catch respectively for 1975 and 1976. Nonresident anglers traveling less than 50 miles made up the majority of the fishermen sampled (50 percent), followed by Montana residents traveling more than 50 miles (39 percent).

The estimated average fishing pressure on the Tongue River Reservoir during the summer for all fish species was 3.0 and 2.6 hours per acre in 1975 and 1976, respectively. Seasonally, the pressure varied in 1975 from a low of 0.4 hours per acre in June to a high of 0.6 hours per acre in September.

In 1976, the low was 0.1 hours per acre in September, and the high was 0.7 hours per acre in May. These fishing pressures are considerably lower than those reported on other warm-water lakes in northern latitudes (Kempinger, et al., 1975). Those authors report fishing pressures ranging from 2.7 to 30.7 hours per acre. The comparatively low fishing pressures on the Tongue River Reservoir indicate that the reservoir may be under utilized as a fishing resource. This under utilization correlates with the low percentage of fish tags returned during the census (see section II. B. 2. b. (2)).

Catch rates for the reservoir are also low in comparison to those reported for other warm-water fisheries (Kempinger, et al., 1975). Fishing success for sport fish in the reservoir averaged 0.3 fish per hour in 1975 and 0.6 fish per hour in 1976. Crappie dominated the catch both years, contributing 66 and 82 percent in 1975 and 1976, respectively (table 33C). The catch rate for crappie increased from 0.2 fish per hour in 1975 to 0.5 fish per hour in 1976. During this same period walleye catch also increased respectively from 0.04 fish per hour to 0.06 fish per hour. The number of bass and northern pike declined from 1975 to 1976 (table 33C). This reduction is consistent with the results of other sampling conducted in 1976 by the Montana Fish and Game Department.

The annual sport-fishery yield on the Tongue River Reservoir varied from 2,681 lbs. (0.76 lbs. per acre) in 1975 to 3,854 lbs. (1.09 lbs. per acre) in 1976 (Table 33C). As with fishery pressure and fishing success, sport-fishery yield is also lower than yields reported by Kempinger, et al. (1975) for other warm-water lakes in northern latitudes.

Table 33C.--Estimated total angling effort and harvest of sport fish, Tongue River Reservoir, 1975 and 1976 [1]

Parameter	1975[2]	1976
Total man-trips	2,211	1,058
Total man-hours	10,392	9,151
Total catch, numbers		
Northern pike	156	64
Bass[3]	482	351
Crappie[4]	1,997	4,386
Sauger	14	24
Walleye	380	516
Total	3,029	5,341
Total catch, (pounds)		
Northern pike	545.40	223.84
Bass [3]	266.00	193.81
Crappie [4]	1,058.94	2,324.94
Sauger	27.81	47.68
Walleye	783.22	1,063.79
Total weight, (pounds)	2,681.37 (0.76 lbs/acre)	3,854.06 (1.09 lbs/acre)
Catch success, (fish per man-hour)		
Northern pike	0.015	0.007
Bass [3]	0.046	0.038
Crappie [4]	0.192	0.479
Sauger	0.001	0.003
Walleye	0.037	0.056
Total	0.291	0.584

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[1] Written communication with Al Elser, Montana Fish and Game Department, January 17, 1977. Creel Census data are from a report in preparation for the Old West Regional Commission.

[2] Winter use of the Tongue River Reservoir is estimated to be 660 man-days per year based on a Montana Fish and Game Department mail survey (Bud Gafne, Montana Fish and Game Department, Division of Planning, personal communication, January 17, 1977).

[3] Includes smallmouth and largemouth bass.

[4] Includes black and white crappie.

8. Aesthetics

An individual's perception of the aesthetic value of an area is the result of complex interactions of his senses. Sight, sound, smell, taste, and touch are all involved in this process. These sensual inputs are moderated by emotional, cognitive, and evaluative human responses that may differ greatly between individuals. Although the visual assessment of an area is subjective, some aesthetic components are quantifiable. (VTN Colorado, 1975b).

Elements that are considered in an aesthetic analysis include land, flora, fauna, water, and air. The color, surface, texture, slope, and form dominating a scene all contribute to the effect on the viewer's perception. (VTN Colorado, 1975b).

The visual effect of the natural environment surrounding the proposed East Decker and North Extension Mines is one of openness and tranquility. Certain aspects of the physical setting contribute to this uniformity. The proposed mines would be located on rolling bench lands where the cumulative effects of erosion has through the ages differentially sculptured the land. This low, rolling landscape and the existing air quality offer the viewer uninterrupted vistas for many miles in all directions.

The flora and fauna of the Decker region blend in with the rest of the physical environment. Vegetation present in the area is dominated by sagebrush-grassland. Where bedrock "breaks" develop, small shrubby coniferous trees occur. Deciduous trees commonly occur only in those areas where moisture is readily available throughout the growing season. Wildlife is an integral part of the natural setting; the camouflaging browns and grays of the deer, antelope, birds, coyotes, etc., blend with similar tones in the soils and vegetation (VTN Colorado, 1975b).

Variability to the scene is provided by the existence of the Tongue River Reservoir. This body of water increases the scenic quality of the area. Additional diversity is produced by gravelly surface soils, rock knob outcrops and steep, eroded river banks.

All of these landscape components instill the feeling of great open spaces that is so often used in reference to the West (VTN Colorado, 1975b).

Man's influence on the aesthetic environment in the Decker area has been relatively minor to date. The ranching industry with its attendant buildings, livestock, and fences, etc., have not detracted from the feeling of openness or tanquility. The existing West Decker mine, however, while detracting little from the feeling of openness, has to some extent disrupted the tranquility of the area.

9. Highways

Route FAS 314 is the principal direct access to the proposed mine areas as well as to the existing West Decker mine. Route FAS 314 starts at the Wyoming-Big Horn County line and extends 33 miles northerly to its junction with U.S. 212, 1.5 miles west of Busby (see fig. 23). The road is a major north-south, farm-to-market route in southeastern Big Horn County.

Nearly 5.1 miles of Route FAS 314 were relocated in 1972-73 at the expense of the Decker Coal Co. to accommodate the opening of the West Decker mine.

The existing highway section in the area of the Decker Coal Co.'s proposed relocation of Route FAS 314 has a 28-foot-wide asphalt surface with a design speed of 60 miles per hour. Traffic counts indicate that approximately 125 vehicles per day currently use the section proposed for relocation. Traffic counts also show that nearly 440 vehicles per day use the section south of the entrance to the West Decker mine. Most of these counts are due to the daily round trip of West Decker mine employees living in the Sheridan area approximately 25 miles to the south.

III. ENVIRONMENTAL IMPACTS OF THE PROPOSALS

A. East Decker mine

1. Topography

The proposed reclaimed surface in the East Decker area (fig. 9) would contain no closed depressions that would impound surface runoff and require special mitigating measures. Dominant features of the reclaimed topography would be (1) an elongate, dissected ridge along the north and west margins of the mined area, (2) an elongate depression along the southeast margin of the mined area, and (3) five essentially straight, northwest-trending "valleys" aligned along reclaimed haul-road depressions.

The elongate ridge along the north and west margins of the mined area would be formed by reclaimed spoil materials excavated from the initial box cuts. This ridge would generally be 100 to 150 feet high and about 1,000 to 1,500 feet wide at the base. Side slopes facing Deer Creek valley and the Tongue River Reservoir would be moderately steep, approaching the maximum allowable slope of 20 percent. Slopes of this magnitude would be subject to excessive sheet and rill erosion unless they are protected by a good plant cover and appropriate land-treatment practices.

The elongate depression along the southeast margin of the mined area would be left by the final cut at the base of the highwall. Although reduction of the slope of the highwall and burial of any exposed coal beds, as required by State law, would partially fill this cut, the final depression would be 50 to 150 feet deep and 500 to 1,000 feet wide at the top. Side slopes would average 20 to 25 percent and would be subject to excessive sheet and rill erosion unless they are protected by a good plant cover and appropriate land-treatment practices.

The essentially straight "valleys" traversing the surface are unnatural in appearance and have side slopes that also would be subject to excessive sheet and rill erosion. Moreover, channels that would be formed artifically or naturally on the bottoms of these straight narrow depressions soon would meander and start eroding the "valley" sides (see discussion of erosion and sedimentation, p. 351).

The primary impact of the proposed mining and reclamation plans on topography, therefore, would be to create a potentially unstable, eroding surface that would not approximately restore the original surface configuration.

2. Soils

Mining in the East Decker area would result in the disturbance or mixing of the topsoil on approximately 2,575 acres. This disturbance would alter climate-soil-plant relationships established during recent geologic time. Moreover, off-road vehicle use might seriously disturb soils in areas adjacent to the mine.

As required by Montana statutes, all soil or underlying materials suitable for use as topsoil would be removed from areas disturbed as a result of mining and disposal of spoil materials or as a result of related activities such as construction of the railroad spur, roads, plant facilities, and the water-diversion system. The original soil profiles would be disrupted in the process, producing generally unfavorable changes in their physical, chemical, and biological characteristics.

Impacts to the environment from soil disturbances generally would be of two types; (1) those affecting the suitability of the replaced topsoil as a medium for plant growth and (2) those affecting runoff, erosion, and consequent sediment yield to downstream areas. Because of the pronounced effect of the plant cover on runoff and erosion, however, clear-cut distinctions are often not possible; soil disturbances that adversely impact the plant cover tend to reduce soil stability and vice versa.

Excavation of the soil veneer by scrapers (fig. 7) in advance of mining or related activities would result in an erratic mixing of the A, B, and C horizons with consequent loss of soil structure, decreased porosity and permeability, and increased bulk density. Replacement of this mixture in a heterogeneous layer up to 18 inches thick over graded spoils would result in a significant dilution of organic material and biological activity in the upper part of the replaced soil veneer. Moreover, the surface and upper layer of the undisturbed soil profile contain plants, plant propagules, and seeds representative of the native community. Burial of these materials during reclamation would reduce the potential for vegetative regeneration of native species (Montana Department of State Lands, 1976a).

Soil disturbances coupled with slope-gradient and slope-aspect changes are expected to significantly alter the premining plant cover, which is currently divided into ecologically distinct communities that closely reflect existing topo-edaphic characteristics. The postmining plant cover would be more uniform in character, at least initially, and would not be divided into the same distinct communities that currently exist in the area (Montana Department of State Lands, 1976b).

Removal of salvable soil materials in advance of mining (fig. 6) would expose the denuded area to accelerated erosion by wind and water. The products of wind erosion would contribute directly to local air pollution; most water-borne sediment would enter the active pit or temporary impoundments in the mine area and would not impact the Tongue River Reservoir. Conversely, soil disturbances related to construction of the railroad spur, roadways, plant area, etc., probably would cause some short-term increase in sediment yield to the reservoir. (see section III. A. 3. b. (5) for a discussion of erosion and sedimentation as a consequence of mining in the East Decker area).

During the initial stages of mining and construction, all salvable soil materials would be stockpiled for later use. As mining progresses, however, soil removed in advance of mining would be transported and placed on recontoured spoils in one operation, avoiding insofar as possible the need to stockpile. Presumably, therefore, soil materials stockpiled in the early stages of mining might not be used until the middle or the final stages of mining. If so, these materials would be exposed to prolonged erosion by wind and water unless adequately protected. Stockpiling for long periods also would significantly reduce biological activity within the soil materials and would reduce the opportunity for natural propagation of a native plant cover once the materials are used.

Topsoil placed on graded spoils as mining progresses would be subject to accelerated erosion by wind and water until a protective plant cover is established. Soils in the East Decker area are predominantly silt and sandy loams and, as such, are especially vulnerable to erosion. Medium sand and larger soil particles are not readily detached by raindrop splash by virtue of their mass and are not easily transported by wind or by water in the absence of well-defined channels. Similarly, fine-grained materials comprising clay and clay-loam soils are not as readily detached and eroded as silt and find-grained sand because of the strong cohesive forces that bind clay-size particles into soil aggregates.

Prolonged erosion of the replaced topsoil may occur, depending on the time of year in which retopsoiling and reseeding are attempted. Establishment of an inadequate plant cover may result if reclamation is injudiciously attempted during unfavorable seasons or during periods of drought. Such erosion would reduce the remaining soil depth in the eroding areas and would tend to form incised rills and gullies that would migrate headward upslope. Local deposition would increase soil thickness in the aggrading areas. This local benefit would not occur, however, if the eroded soil materials are deposited in the Tongue River Reservoir.

Improper preparation of the graded spoil surface before retopsoiling may retard soil-moisture penetration to depth by forming a zone of low permeability at the contact of the topsoil with the underlying spoil materials. Saturation of the replaced topsoil in that event may cause soil slippage on the steeper slopes with consequent adverse impacts on the plant cover. The onset of rill and channel erosion probably would follow the disruption of the surface configuration by such soil movement.

No sodic-soils problems are expected in the East Decker area provided that spoil materials obtained from below the uppermost coal bed are buried at least eight feet below the surface. Should these materials be placed at depths of less than eight feet, sodium salts may cause soil crusting and reduced permeability. Excessive runoff and erosion would follow. Moreover, reduced infiltration would decrease soil moisture for plant growth, resulting in an inadequte protective plant cover. Rill and gully erosion initiated in such areas would tend to extend laterally into adjacent areas with time, thereby compounding the problem.

Use of reclaimed areas by livestock probably would not begin until at least five years after disturbed areas are regraded, topsoiled, and reseeded. If reclamation is unsuccessful, the utility of the soils will have been relinquished in part for coal production.

3. Water resources

a. Effects on ground water

Impacts of the proposed mining plan in the East Decker area generally would be similar to those described for current mining in the West Decker area. They include: Removal of parts of certain aquifers; interruption of premining ground-water flow by the pit; modification of ground-water flow by replaced spoil materials; changes in water guality caused by leaching of spoil materials; effects of blasting; and changes in water levels. Amplification of these impacts follows.

(1) Removal of parts of certain aquifers

A primary impact of surface mining in the East Decker area would be the unavoidable removal of parts of certain aquifers within the mine area. Aquifers adversely affected include the Anderson, Dietz 1, and Dietz 2 coal beds; saturated beds and lenses of permeable sandstone in the overburden and interburden; and saturated zones in clinker and alluvial deposits. The approximate extent of aquifers that would be removed is as follows:

Aquifer	Approximate area to be removed (mi^2)
Anderson coal	2
Dietz 1 coal	3.5
Dietz 2 coal	2
Sandstone	less than 2
Clinker	1.5
Alluvium	less than .5

Those parts of aquifers that are removed would be replaced by a single aquifer comprised of spoil materials. Studies by Rahn (1975) indicate that spoil materials obtained from the Tongue River Member of the Fort Union Formation range widely in permeability, depending on whether the spoils were moved by a dragline or by a scraper. Dragline-laid spoils, which undergo gravity sorting (fig. 44) and minimal compaction by machinery, are almost a hundred times more permeable than scraper-laid spoils, which are not sorted and undergo considerable compaction by the scraper wheels. Data reported by Rahn (1975) show that dragline-laid spoils near Monarch, Wyoming (fig. 23) have an average hydraulic conductivity (permeability) of 35.3 ft/d; scraper-laid spoils at the nearby Big Horn mine (fig. 23) have an average hydraulic conductivity of only 0.4 ft/d. Therefore, the spoil aquifer in the East Decker area, which will be largely excavated and moved by dragline, should have a greater long-term capacity to store and transmit ground water than the combined total of the removed aquifers. Hence, the spoil aquifer can be expected to yield larger quantities of water to wells than the combined total of the original aquifers. The quality of water in the spoils aquifer, however, would probably be simliar to that in the overburden sandstone aquifer. If so, the water in the spoils aquifer would have a dissolved solids content ranging from about 4,000 to 7,000 mg/1, with sodium and sulfate comprising the major constituents. Thus, water obtained from wells tapping the spoils aquifer probably would be unusable for domestic supplies and would be only marginally usable for stock-water supplies.

(2) Interruption of ground-water flow by the pit

The opening of the intial box cut along the west and north margins of the porposed mine area would create a new sink or low point in the ground-water flow system. The effect would be to interrupt natural ground-water movement through the mine area toward the Tongue River Reservoir. Flow in truncated aquifers would be intercepted by the box cut. Also, the hydraulic gradient between the mine and the reservoir would be reversed such that water would move generally eastward from the reservoir and southward from saturated alluvium underlying Deer Creek toward the box cut.

Inflow to the box cut from the reservoir would enter largely through two permeable areas where saturated alluvium or clinker is exposed. The largest inflow probably would occur in the southern third of the western limb where the box cut would expose alluvium and some clinker underlying Coal Creek valley and the east edge of the Tongue River Reservoir. A lesser amount of inflow probably would occur where the box cut exposes alluvium underlying Middle Creek valley.

Inflow to the mine from alluvium underlying Deer Creek valley is expected to enter the northern limb of the box cut in three areas. The first inflow as the box cut is excavated should occur in the reach 2,000 to 3,000 feet east of the initial scraper pit where both saturated alluvium and clinker would be exposed. Continuation of the box cut eastward an additional 3,000 feet should expose a second area of saturated alluvium on the south side of Deer Creek valley. The third area would be exposed at the eastern end of the box cut where the base of the clinker formed by burning of the Anderson coal occurs below the premining level of saturation. This reach extends about 900 feet east and west of the line between sections 7 and 8, T. 9 S., R. 41 E. Very probably the interception of underflow in Deer Creek valley in the easternmost segment of the box cut would progressively decrease inflow in the two downstream reaches previously described.

Ground-water inflow to the mine from the south and east should occur largely from exposed coal beds and clinker. Most inflow of ground water from coal beds is expected to be initially from the Dietz 1 and Dietz 2 beds, with only a very minor contribution from the Anderson bed. As mining progresses southward and eastward, discharge from the Anderson bed should increase as a greater width of this bed is exposed in the high wall.

Significant inflow to the mine from the south and east direction is also expected from clinker underlying the surface of about 1½ square miles in the eastern half of the proposed mine area. Inflow probably would begin at a relatively high rate and should decrease progressively with time as water is removed from storage. The time required to dewater the clinker depends on the rate of discharge to the mine, the volume of ground water in storage, and the amount of recharge from precipitation. Although data are not available from which to approximate the rate of dewatering, very probably the clinker, which contains an estimated 500 to 1,000 acre-feet of water in storage, would be largely drained within 5 to 10 years. Thereafter, inflow to the mine from the clinker should about equal the rate of recharge to the clinker from precipitation.

Estimates of the probable amounts of inflow to the initial box cut during construction and one year after completion of each limb are presented in table 34. These estimates are based on calculations of the amount of ground water that is expected to enter the box cut (1) from the reservoir and from underflow in Deer Creek valley, (2) from movement of ground water at the premining rate through aquifers exposed in the mine area, and (3) from storage in these aquifers as water levels are progressively lowered by dewatering of the mine.

In summary, the following impacts of the proposed mine on ground-water flow are recognized: (1) Inflow to the mine would be induced from the nearby Tongue River Reservoir through two areas where saturated

Table 34.--Estimated inflow of ground water during and after construction of the initial box cuts in the East Decker mine

Elapsed time from start of construction (days)	Length of box cut (feet)	Estimated inflow							
		From Tongue River Reservoir & underflow in Deek Creek valley (ft^3/s)		From aquifer discharge 1/ (ft^3/s)		From aquifer storage (ft^3/s)		Total (ft^3/s)	
		Low	High	Low	High	Low	High	Low	High
				WESTERN LIMB OF BOX CUT					
30	1500	0.10	0.20	0.03	0.05	0.03	0.05	0.16	0.30
180	9000	1.60	2.20	.06	.13	.01	.02	1.67	2.35
545 2/	9000	1.60	2.20	.10	.20	less than .01		1.70	2.40
				NORTHERN LIMB OF BOX CUT					
60	3000	0.04	0.05	0.03	0.05	0.06	0.07	0.13	0.17
120	6000	.04	.05	.10	.15	.20	.27	.34	.47
200	10200	.04	.05	.15	.22	.40	.48	.59	.75
565 2/	10200	.04	.05	.15	.22	.10	.13	.29	.40

1/ Assumed to be equal to the premining rate of ground-water flow to the Tongue River Reservoir.
2/ One year after completion of initial box cut.

alluvium or clinker would be exposed in the pit. Although variable depending on reservoir stage, inflow from the reservoir should range between 1.6 to 2.2 ft^3/s (700 to 1,000 gal/min) and probably would continue throughout the life of the mine. (2) Most of the ground water moving through the mine area prior to mining (table 12) would be intercepted by the strip pit. An exception is flow through the alluvium underlying Deer Creek. As only the upper part of this aquifer would be exposed in the box cut, not all underflow in Deer Creek valley would enter the pit. (3) Additional inflow to the mine from ground-water storage is estimated to be 0.40 to 0.50 ft^3/s (180 to 225 gal/min) during the early stages of mining. As mining progresses, inflow from storage should decrease to less than 0.10 ft^3/s after about 5 years. (4) There should be a small net gain of water to the reservoir during the life of the mine, because water pumped from the mine will be returned to the reservoir. Use of mine effluent for dust control is estimated to be about 45,000 gal/day or about 30 gal/min, which should be less than the long-term rate of withdrawal of water from ground-water storage in the East Decker area.

(3) Modifications of ground-water flow by replaced spoil materials

As the location of the active pit progresses southward and eastward, spoil materials will be replaced in the mined out area so that, in effect, the spoil will be interposed between the active pit and the exposed alluvial aquifers contributing inflow along the east side of the Tongue River Reservoir and the south side of Deer Creek valley. It is conceivable that spoil materials would impede the inflow of ground water from the alluvium if the spoil placed opposite the points of inflow is less permeable than the alluvium. This possibility exists because the alluvial aquifers will be exposed in the upper part of the initial box cut some distance above the mine floor. Observations indicate that the upper part of the spoil is generally much less permeable than the lower part, which often contains coarse rubble zones as a result of gravity sorting (fig. 44).

The probability of reducing inflow from the alluvium is believed to be greatest along the western limb of the box cut adjacent to the reservoir. The spoil in this area should consist essentially of mixed sandstone, siltstone, and shale. The reduction in flow will depend in part on the difference in permeability between the replaced spoil and the alluvium and in part on the hydraulic gradient in the spoil. Although data are generally lacking on the hydraulic properties of replaced spoil materials, very probably the rate of inflow from the reservoir will not be reduced by more than 25 to 50 percent. Spoil materials placed opposite inflow areas along the north limb of the box cut would probably consist largely of clinker with some admixture of overburden and interburden materials. Clinker in place is generally highly permeable, but the permeability of spoils derived largely from clinker might be even higher owing to the increased porosity that should result. Hence, it seems unlikely that spoils composed chiefly of clinkered material would significantly impede ground-water inflow from the north.

The major impact of the replaced spoil on ground-water flow will not be evident until active mining is completed. At that time, dewatering of the mine and consequent discharge of mine effluent water to the reservoir would cease. Ground-water movement from the reservoir to the mine, however, would continue until the spoil is saturated to reservoir level. The time required to saturate the spoil in the mined-out area would depend on the volume of void space in the spoil that remains to be saturated and on the rate of inflow of water to the spoil. Judging from the volume of spoils in the East Decker area that must be saturated and from the probable rate of inflow to the spoils, it may take 5 to 10 years to saturate these materials. During that period, the movement of ground water would be from the reservoir toward the East Decker mine area. Initially, flow from the reservoir to the mined-out area is expected to range from about 1.6 to 2.2 ft^3/s (700 to 1,000 gal/min). The flow, however, would decrease progressively until the spoil is saturated to reservoir level. Thereafter, ground-water discharge across the mined-out area toward the Tongue River Reservoir should resume and increase gradually to the premining rate of about 0.5 to 0.8 ft^3/s (225 to 360 gal/min).

(4) Changes in water quality caused by leaching of spoil materials

As ground water accumulates in the replaced spoil, solution and interaction with soluble minerals in the spoil materials are expected to significantly change the quality of the ground-water resource. Although definitive analytical data are lacking from which to predict the effects of leaching on water quality, some inferences can be drawn from knowledge of the chemical character of the ground water that occurs in the aquifer materials which will be converted to spoil.

In the East Decker area, the bulk of the spoil material would be composed of overburden and interburden sandstone, siltstone, and shale. Thus, the quality of the leachate from the spoil material should bear a close resemblance to the quality of ground water in the overburden sandstone aquifers. As previously indicated, this water is generally highly mineralized, having values for specific conductance usually in excess of 5,000 micromhos/cm (table 13). Moreover, analytical data reported by Van Voast and Hedges (1975, table 3) indicate that ground water in the overburden is rich in sodium and sulfate, and has a sodium adsorption ratio in excess of 50. These data strongly suggest that the ground water from the East Decker mine area, after rehabilitation is completed, would contain somewhat more than 4,000 mg/l dissolved solids and would have a sodium adsorption ratio in excess of 50. The inferred effect on the quality of reservoir water is discussed in section III. C. 3. a. (5).

(5) Effects of blasting

Repeated blasting to facilitate removal of overburden and coal during mining operations in the East Decker area would generate a series of small seismic shock waves. Although shock waves generated by individual blasts are rapidly dissipated by surrounding earth materials, the seismic effects may produce objectionable turbidity in nearby wells. For example, blasting at the West Decker mine reportedly caused the water from Emmett Munson's domestic well in sec. 22, T. 9 S., R. 40 E., to turn black for a period of about 1 week in August 1975. Evidently, shock waves dislodged enough tiny particles of coal from the inside of the well to discolor the water. Such occurrences are not unusual within a mile or two of sudden disturbances, such as those caused by explosives.

In addition to the seismic effects, the use of nitrate explosives in the East Decker area probably would introduce some nitrogenous compounds into the spoil from which it subsequently can be leached by ground water and added to the mine effluent. Van Voast and Hedges (1975, p. 15) report sporadic occurrences of up to 110 mg/1 of nitrate in the effluent from the West Decker mine.

(6) Changes in water levels

During operation of the East Decker mine, pumping to dewater the active pit would lower the hydrostatic head in each of the aquifers exposed in the mine. As this occurs, water levels in nearby wells would decline. The amount of decline in any given well would depend on several factors. In general, the largest declines are expected in wells completed in the lowermost confined aquifer exposed by mining; conversely, the smallest declines should occur in wells completed in the shallow unconfined aquifers, such as alluvium and clinker. Within each aquifer, water-level declines should be greatest in wells nearest the active pit and should diminish with increasing distance away from the pit.

The maximum decline in water levels that would be expected in wells in the East Decker area as a result of dewatering the mine can be approximated from the difference in elevation between premining water levels and the bottom of the aquifers exposed in the mine. In general, this difference is greatest in the southwestern corner of the mine area and least in the northeastern corner. The approximate ranges of water-level declines that might occur in wells near the margins of the active pit are as follows:

Aquifer	Inferred water-level declines Northeast corner	Southwest corner
Alluvium	Less than 10 feet	10 feet
Clinker	20	N.A.
Anderson coal bed	30	100
Dietz 1 coal bed	60	130
Dietz 2 coal bed	120	180

Very probably the effects of mining on water levels in wells in the East Decker area will be confined to the area within the hydrologic boundaries formed by the Tongue River Reservoir on the west, the alluvial-floored valley of Deer Creek on the north and the two faults that form the southern and eastern margins of the mine area. Within this area are 11 existing wells, 10 of which are currently being used as a source of water supply. Included in this group are the following wells:

No.[1]	Location T., R., Section	Owner
52	9 S., 40 E., 11 ADAB	Decker Coal Co.
53	9 S., 40 E., 11 ADAC	Decker Coal Co.
54	9 S., 40 E., 13 CAAA	Decker Coal Co.
65	9 S., 40 E., 22 DAAD	Emmett Munson
66	9 S., 40 E., 22 DADA	Emmett Munson
67	9 S., 40 E., 24 ABAB	Holmes Ranch
68	9 S., 40 E., 24 ABBB	Decker Coal Co.
79	9 S., 41 E., 7 ADCA	Decker Coal Co.

80[2]	9 S., 41 E., 7 CCBD	Decker Coal Co.
81	9 S., 41 E., 8 CACD	Decker Coal Co.
82	9 S., 41 E., 8 CDBD	Decker Coal Co.

[1] Sequential number of well (see listing in table D-1, Appendix D).

[2] Well not used.

Five of these wells (nos. 54, 79, 80, 81, and 82) lie within the area to be mined and would be physically destroyed. Two others (nos. 67 and 68) probably would be rendered useless or seriously impaired because they lie very near the southern limits of mining and would incur excessive water-level declines. The remaining four wells should be only minimally affected because they are adjacent to the Tongue River Reservoir where water-level declines should be small.

b. Effects on surface water

Impacts of the proposed mining plan on surface water in the East Decker area include: Alteration or removal of all existing stream channels within the area mined; interception and diversion of runoff around the proposed mine area; and consequent downstream effects of these modifications of the natural stream regime on quantity of water, chemical quality of water, and erosion and sedimentation. Amplification of these impacts follows:

(1) Alteration or removal of existing stream channels

A primary impact of surface mining in the East Decker area would be the alteration or removal of all natural stream channels within and adjacent to the area mined. Channels adversely affected include those of Deer Creek, Middle Creek, Coal Creek and a number of comparatively small unnamed ephemeral streams that are tributary to the above channels or that discharge directly to the Tongue River Reservoir (fig. 10). Types of channel disturbance and related information are as follows:

Stream channel	Types of disturbance	Length of valley to be disturbed (miles)	Average valley slope[1]	Average channel slope[2]
Deer Creek	Channel to be locally filled with spoils	2.1	0.0053	0.0030
Middle Creek	Channel to be removed	1.7	.011	.0076
Coal Creek	Channel to be removed	1.1	.013	.0098
Other unnamed streams[3]	Channels to be removed	9.2	.022	.020

[1] Measured on valley floor along centerline of valley.

[2] Measured along meandering course of stream channel.

[3] Includes measurements of 14 small ephemeral stream valleys.

Alteration or removal of the above stream channels as a result of mining in the East Decker area would, in the absence of appropriate diversion channels, cause flooding and deposition of sediment in the active pit. This flooding in turn would cause frequent and unpredictable production delays and probably would necessitate the use of washing facilities to remove the sediment from the coal. In the event that all the sediment cannot feasibly be removed from the coal, some wastage of the coal resource or increase in ash content would occur.

Although all channels would be removed within the mine area, the active pit would encroach only minimally on the Deer Creek channel, which roughly parallels the north margin of the mine area (fig. 10).

The Deer Creek valley and its function as a natural drainage course would be altered significantly, however, by spoiling overburden from the initial box cut into the southern half of the valley and by constructing a railroad loop on compacted fill placed across the full width of the valley mouth. No culverts would be installed beneath this railroad embankment; therefore, any surface runoff to the lower reach of Deer Creek valley would be impounded by this fill. Similarly, spoils placed in Deer Creek valley upstream from the railroad loop would locally fill the existing channel in those reaches where the meandering stream occupies the south side of the valley. This would disrupt the continuity of the existing channel and create a number of small discontinuous channel segments that would function as small impoundments within this altered reach of the valley.

The effect of channel alterations on the quantity and quality of surface runoff is discussed on pages 337-341.

(2) Interception and diversion of runoff

Alteration of existing stream channels within and adjacent to the mine area requires the construction of earthen dams and diversion channels to intercept and carry surface runoff around the mine area (fig. 10). This diversion system would (1) alter the existing flow regimen in natural channels downstream, (2) change the physical character and appearance of the landscape, (3) destroy the existing plant cover on borrow and fill areas, and (4) locally modify the small animal habitat.

As indicated in the following table, the proposed design capacity of all diversion channels in the East Decker area appears to be more than adequate to carry an estimated 100-year flood.

Stream diversion	Design capacity (ft^3/s)	Estimated peak discharge from 100-year flood (table 16) (ft^3/s)
Deer Creek	6,000	3,600
Middle Creek	1,800	1,200
Coal Creek	1,000	840

Proposed diversion channels excavated in earthen materials in the East Decker area have been designed for flow velocities up to about 8 ft/s (table 35). These velocities would be highly erosive in unconsolidated materials derived from weathering of the bedrock that underlies the surface in the East Decker area. Susceptibility of these unconsolidated materials to erosion by comparatively small flows is demonstrated by the Pond Creek Diversion in the West Decker area (fig. 50).

Proposed concrete-lined channels are designed for flow velocities of as much as 47 ft/s. These high velocities would be extremely erosive (p. 346) and would require frequent and extensive maintenance of the system.

Secondary diversion ditches and small impoundments used to control runoff within the mine area would be temporary and should not significantly impact the environment.

According to the proposed mining and reclamation plan, stream valleys disrupted by mining would not be restored to their approximate original configuration and gradient so as to resume their function as essentially stable drainage courses. Deer Creek would be left permanently relocated in the diversion channel shown on figure 10 and described on pages 40 and 41. Once maintenance of this diversion by the Decker Coal Co. is discontinued, failure of the system is inevitable.

Apparently, the Decker Coal Co. also intended that Middle and Coal Creeks would be left permanently relocated in their respective diversion channels (VTN Colorado, 1975, p. 225). No such statement is made, however, in the mining and reclamation plan submitted by the Decker Coal Co. to the U.S. Geological Survey and the Montana Department of State Lands. As the proposed plan has not been amended as of March 1976 to clarify this point, it must be assumed that the proposed Middle and Coal Creek diversions would not be permanent and that these streams eventually would be channeled over the highwall and across the mined area to the Tongue River Reservoir.

The proposed diversion channels for Middle and Coal Creeks, like the diversion channel for Deer Creek, would require periodic maintenance to function properly. Once maintenance is discontinued, failure of the system is inevitable. Conversely, with proper design and control measures, ephemeral streams traversing the East Decker area could be routed over the highwall and across the mined area in channels that probably would be as stable as natural channels over the long term. The erosional stability of channels in the East Decker area is discussed at length in the section on Erosion and sedimentation (p. 349-352).

(3) Changes in quantity of water

It is estimated that surface runoff and consequent water yield to the Tongue River Reservoir from streams traversing the East Decker area would be reduced no more than about 12 percent, about 125 acre-feet annually during mining, and no more than about 6 percent, about 65 acre-feet annually after mining and reclamation (table 46). This loss of water to the reservoir represents less than four-hundredths of 1 percent of total annual inflow to the reservoir during the period of mining and less than two-hundredths of 1 percent of total annual inflow to the reservoir after mining. These estimates were obtained by the following reasoning:

Diversion impoundments on Middle and Coal Creeks and on their larger tributaries (fig. 10) would probably function very much like the existing structure on Pond Creek (p. 201). They would retain and dissipate essentially all runoff generated by small storms on their respective watersheds, but would retain only a comparatively small amount of the runoff generated by large storms. Seepage losses would be appreciable and would move downstream as underflow in the alluvium underlying the valley floor. Most of this water would enter the active pit as ground-water flow and would be discharged to the Tongue River Reservoir. With time, the impoundment basins would progressively fill with sediment, thereby decreasing the volume of water stored. Very probably, therefore, evapotranspiration losses would decrease progressively with time. These losses would never be eliminated, however, because of the natural water-spreading that would occur on the alluvial deposits accumulated within and extending upstream from the impoundments. It is estimated that as much as half the surface runoff from these watersheds upstream from the diversion would be dissipated by evapotranspiration during the early stages of mining when the retention capacity of the structures is greatest. Evapotranspiration losses should decrease to less than 10 percent after mining is completed and the impoundments have been removed. Runoff, both during and after mining, from those parts of Middle and Coal Creek watersheds that lie within the mine area should be no less than about 50 percent of the premining amount.

Conversely, the channel diversion on Deer Creek probably would not significantly reduce runoff from the watershed upstream from the mine area to the Tongue River Reservoir. The diversion structure would have little or no initial storage capacity; any initial capacity would rapidly be filled with sediment because of the comparatively large size of the watershed. Moreover, the high level of saturation in the alluvium underlying the valley floor (p. 204) currently provides subirrigation for riparian vegetation. Losses from evapotranspiration, therefore, should not be significantly more than are presently occurring along the Deer Creek channel, and any accretion to ground water probably would eventually reach the reservoir undiminished. Runoff from the Deer Creek watershed within the mine area, both during and after mining, should not be less than about 50 percent of the premining amount.

The foregoing estimates of surface-water losses in the East Decker area as a result of mining are probably on the high side. It should be stressed, however, that in the unlikely event that these losses were double the estimated amount, the long-term impact on the Tongue River Reservoir would be a reduction of inflow of less than five-hundredths of 1 percent.

The inferred loss of water to the Tongue River Reservoir as a result of mining would be partly, if not largely, offset by (1) a possible reduction of sediment yield to the reservoir (p. 353), (2) the added availability of water for livestock and wildlife afforded by storage of water in the diversion impoundments, and (3) increased forage production in those areas where natural water spreading on alluvial deposits extending upstream from the diversion structures would provide additional water for plant growth.

Standing pools of water in the middle reaches of Deer Creek are fed by underflow moving downstream through the alluvium (p. 201). As all of these pools are upstream from the reach where underflow in Deer Creek would be partially intercepted by the mine (p. 324), they should not be adversely impacted by mining. Standing pools in the lower reaches of Middle and Coal Creeks would be eliminated when these valleys are removed by mining.

(4) Changes in chemical quality of water

Surface runoff diverted around the mine area to the Tongue River Reservoir should undergo little or no change in chemical quality. However, water that infiltrates the surface and augments ground-water recharge as a consequence of mining and reclamation can be expected to leach and transport higher concentrations of dissolved solids than a comparable flow that remains on the surface. The dissolved-solids content and rate of ground-water flow during and after mining in the East Decker area is discussed on p. 323-330. The impact of this water on the Tongue River Reservoir is described on p. 443.

Evaporation of waste water from the plant area in clay-lined lagoons (p. 52 and fig. 11) should present no problems to local pollution of the ground-water resource or the nearby Tongue River Reservoir, either from seepage or from overflow. The proposed lagoons should be more than adequate to evaporate the anticipated annual discharge of waste water of about 8 acre-feet. The location of the lagoons inside the railroad loop and their height above reservoir spillway level of about 7 feet should prevent any flooding. Adequate emergency measures in the form of protective dikes could be initiated in the event of extreme local flooding. Seepage or outflow from plant settling ponds, which would be used to remove sediment from wash water used to clean machinery, should not present a pollution problem.

(5) Erosion and sedimentation

(a) Stability of diversion dams

Properly designed diversion dams of the size and type proposed on Deer Creek, Middle Creek, and Coal Creek channels should present no stability problems over the life of the proposed mine. These structures could fail, of course, if they are overtopped by runoff that exceeds the design capacity of the diversion system or because of loss of capacity from sediment deposition. In that unlikely event, some flooding of the mine probably would occur, but because of the large area of the pit, any threat to the safety of men or equipment would be small. Because flooding as a result of structural failure in response to excessive runoff would be contained largely within the mine area, environmental damage to the Tongue River Reservoir under these circumstances probably would be less than in the absence of mining.

The diversion dam on Deer Creek would divert runoff directly from the Deer Creek channel into the diversion channel with little or no impoundment of water. Ephemeral flows, therefore, should enter the diversion channel essentially unimpeded without a significant change in either flow velocity or direction. Little erosion or sedimentation is expected, therefore, at the point of diversion or in the reach immediately upstream from the diversion. If so, the Deer Creek diversion dam should require minimal maintenance in the absence of excessive peak discharges.

Conversely, the diversion dams on Middle and Coal Creeks would impound runoff and, therefore, would function as both diversion and flood-control structures. Runoff from the contributing watersheds must pass through the reservoir basins before entering the diversion channels. Thus, these impoundments would function effectively as sediment-settling basins. The trap efficiency of these structures, although uncertain, would probably exceed 75 percent; that is, more than 75 percent of all fluvial sediment in transport would be deposited upstream from the diversions. With significant runoff and sediment yield over time, the reservoir basins would progressively fill with sediment, thereby decreasing both the effect of the impoundments on flood control and the freeboard or elevation difference between the top of the dam and the bottom of the reservoir. Sediment deposition would not be confined to the reservoir basin, but would progress headward, upstream, as the impoundment fills with sediment and flows spread across the aggrading valley floor. The effect is much like that of an alluvial-fan deposit building upstream.

The proposed Middle Creek and Coal Creek diversion structures should function adequately with minimal maintenance over the proposed life of the East Decker mine, a period of about 20 years. Beyond that time, however, the progressive loss of storage capacity and the reduced freeboard would combine to increase the probability of overtopping and structural failure during any given year. Ultimate failure is certain in the absence of continued maintenance. When that happens, runoff from the Middle Creek and Coal Creek watersheds would move through the breached structures, over the highwall, and across the mine area through haul road depressions (fig. 9). Similarly, the Deer Creek diversion structure also would eventually be overtopped by excessive runoff and would fail in the absence of maintenance. Flows once again would enter the lower reaches of Deer Creek valley and would cut a new channel across the obstructing spoils materials to the Tongue River Reservoir.

(b) Stability of diversion channels

Neither the unconsolidated materials underlying the surface in the East Decker area or the topography present any serious challenge to the design and construction of essentially stable diversion channels that would carry surface runoff around the mine area. The proposed channels, however, generally would not be stable because they have been designed for abnormally high flow velocities, and almost certainly, would be subject to severe local erosion and consequent failure. Calculated maximum flow velocities for selected runoff events are listed in table 35. Calculations are based on design criteria furnished by the Decker Coal Co.

Table 35.--Calculated maximum flow velocities in diversion channels in the East Decker area

Diversion	Type of channel	Mean flow velocity for peak discharges having the indicated recurrence intervals[1/] (ft/s)					
		2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
Deer Creek	Earthen with riprap lining	3.5	5.1	5.9	6.8	7.5	8.1
Middle Creek	Earthen	3.0	4.4	5.2	6.1	6.7	7.2
	Concrete	14	22	27	32	36	39
Coal Creek	Earthen	2.7	4.0	4.8	5.6	6.1	6.6
	Concrete	20	27	33	39	43	46

[1/] Estimated peak discharges are given in table 16.

According to the U.S. Department of Agriculture (1972a), allowable velocities for flows in noncohesive earthen channels depend primarily on the grain size of the channel materials and on the sediment concentration of the flow. Generally, the larger the channel materials or protective riprap lining and the higher the sediment concentration, the higher would be the allowable velocity. For example, the Deer Creek diversion, if protected by coarse riprap up to 6 inches in diameter, would have an allowable velocity of as much as 10 ft/s, provided that no appreciable sedimentation occurred in the channel upstream from the diversion. Any reduction in sediment load would tend to increase the erosiveness of the flow in the channel downstream and require a corresponding reduction in velocity. In contrast, the allowable velocity in the Middle Creek and Coal Creek diversions, neither of which would be protected by riprap lining, would be no more than about 3 ft/s. The low allowable velocity in these diversions is attributed to the noncohesive, fine-grained character of materials underlying the surface in the south and eastern parts of the East Decker area and to the probable deposition of most of the sediment load in the impoundments upstream from the diversion.

It follows from the foregoing discussion and table 35 that the proposed Deer Creek diversion channel probably would be stable over the life of the mine, depending on the size of the riprap lining and the adequacy of maintenance. In the absence of periodic maintenance, however, it is doubtful that the diversion would function properly as a permanent channel for Deer Creek. This man-made channel would be excavated in unconsolidated alluvial and colluvial materials along the north side of Deer Creek valley for a distance of about 7,400 feet downstream from the diversion dam. The channel then would turn generally northward following an abandoned ancient channel of the Tongue River. The first 7,400 feet of channel literally would be perched on the valley sideslope with the bottom of the diversion channel as much as 10 feet higher than the level of the nearby abandoned channel of Deer Creek. Moreover, no provisions have been made to accommodate inflow from tributaries entering the diversion channel from the north.

Once maintenance is discontinued, a breach in the diversion channel probably would eventually occur because of local scour, overtopping of the channel during major flooding, or seepage and consequent slumping or sliding of the unconsolidated materials downslope into the old channel of Deer Creek. Once the diversion is breached, all runoff would again enter the lower reaches of Deer Creek valley and cause extensive erosion of the reclaimed spoil materials, followed by deposition of the derived sediments in the Tongue River Reservoir.

The proposed Middle Creek and Coal Creek earthen diversion channels probably would be subject to erosion by all peak discharges having recurrence interval of more than 2 years. Extensive downcutting of the type shown in figure 50 would be expected, yielding large quantities of sediment to settling ponds downstream and necessitating extensive maintenance of the entire system. The high-velocity concrete channels also would be subject to extreme erosive forces and probable failure during high peak discharges. Problems associated with high velocities such as cavitation, negative pressures, energy dissipation, and the transition from concrete to earthen channels would be difficult to resolve and probably would require extensive maintenance.

(c) Sedimentation in settling basins

According to the proposed mining plan, sediment settling ponds would be constructed near the outlets of the Deer Creek and Coal Creek diversion channels to reduce sediment yield to the Tongue River Reservoir. The settling pond on Deer Creek (p. 41) would have an initial capacity of 41 acre-feet; the settling pond on Coal Creek (p. 44) would have an initial capacity of about 18 acre-feet. Runoff through the Middle Creek diversion would be routed through the Deer Creek settling pond.

Assuming that most sediment from the Middle Creek watershed would be deposited upstream from the diversion impoundment, sediment yield to the Deer Creek settling pond from the Deer Creek watershed probably would average 10 to 15 acre-feet annually (table 18). Assuming a trap efficiency of at least 50 percent, the settling pond would have an effective life of only about 5 to 8 years. To maintain the effectiveness of this structure, therefore, it would be necessary to remove the sediment from the pond periodically over the period of mining. No provisions have been made for the disposal of these excavated materials.

Most of the sediment yielded by the Coal Creek watershed would be deposited upstream from the diversion impoundment. The design capacity of the Coal Creek diversion settling pond, therefore, should be more than adequate to store sediment over the life of the mine, provided that large quantities of sediment are not eroded from the diversion channel.

(d) Erosion of soil materials and spoil embankments

Disturbance of the ground cover, local removal and stockpiling of soil materials, and the formation of steep spoil embankments prior to reclamation should significantly increase erosion by both wind and water within the mine area.

The products of erosion by water would be retained largely within impoundments in the mine area or would enter the active pit and would be trapped in settling ponds before discharging the mine effluent to the Tongue River Reservoir. Erosion of the boxcut spoils along the west margin of the mine might contribute some additional sediment to the Tongue River Reservoir. Sediment derived from erosion of the boxcut spoils along the north margin of the mine would be trapped in the lower reach of Deer Creek valley.

Erosion by wind of disturbed areas where the soil has been removed prior to mining of soil and coal stockpiles and unreclaimed spoil piles may produce large amounts of dust. Because of the prevailing westerly winds, most of the products of this erosion would be deposited in the eastern part of the mine area or in the Deer Creek watershed. Comparatively little would directly enter the Tongue River Reservoir. The impact, therefore, would be largely to air quality and to loss of soil materials for subsequent reclamation, rather than to any significant degradation of the environment in the areas of dust accumulation.

(e) Erosion along roadways

Appreciable erosion by wind and water is expected along roadways constructed or relocated in conjunction with mining activities. The products of wind erosion, like those from other disturbed areas, would be deposited largely downwind in the eastern part of the mine area or in the adjacent Deer Creek watershed. The impact would be largely to air quality, as these wind-blown sediments should not accumulate to a depth of more than a few inches and possibly might enhance the growth of the plant cover by increasing the infiltration capacity of the existing soils.

The products of erosion by water of virtually all roads within the mine area would be retained within impoundments and settling ponds in the mine area and would not reach the Tongue River Reservoir. The notable exception would be the mine access road along the west margin of the mine area (fig. 10). Although the surface of this roadway would be protected by a resistant coating, the west embankment would be subject to wave erosion during periods of high water levels in the Tongue River Reservoir (fig. 47A). In the absence of adequate protection, wave action could erode large volumes of sediment from this roadway. Virtually all of this sediment would be deposited within the reservoir basin.

Relocation of the county road (p. 46) would cause a short-term increase in local erosion during construction and revegetation operations. Thereafter, erosion along the relocated roadway should be no greater than along the existing county road. The products of erosion by water would enter the Coal Creek and Middle Creek diversion systems (fig. 10) and, therefore, should be largely retained in the diversion impoundments or sediment settling ponds.

(f) Stability of postmining channels

As previously stated (p. 345), the proposed Deer Creek diversion system would not function as a permanent drainage course for the Deer Creek watershed in the absence of continued maintenance. A parallel statement can be made for the Middle Creek and Coal Creek diversion systems. It is necessary, therefore, to speculate on the probable character and stability of the natural channels that ultimately would develop to carry runoff and sediment from the Deer Creek, Middle Creek, and Coal Creek watersheds to the Tongue River Reservoir.

Perhaps the simplest of these geomorphic processes would be the reestablishment of a stable channel through the lower, partially filled reach of Deer Creek valley. Initially, the stream probably would integrate the remaining parts of the old channel not filled with spoil materials into a continuous channel by cutting across old meander bends at the north edge of the spoil materials that fill the southern part of the valley. Outlet to the Tongue River Reservoir would be gained by eroding a channel across the railroad-loop fill blocking the valley mouth. This shortened channel would have a steeper gradient than the present channel, giving rise to higher flow velocities at any given discharge and channel cross section. The result would be increased bank erosion and possibly some downcutting, although the latter would be limited by the coarse-grained materials underlying the valley floor below the level of the present channel. Eventually, the channel width, depth, slope, and roughness would readjust through processes of erosion, deposition, and plant growth to form an essentially stable channel in approximate equilibrium with watershed flow and sediment yield characteristics. The products of this erosion, possibly several hundred acre-feet of sediment, would be largely carried into the Tongue River Reservoir.

On removal or ultimate failure of the Middle Creek and Coal Creek diversion impoundments, flows would enter the mined area over the highwall and would follow haulroad depressions to the Tongue River Reservoir (fig. 9). Data from figure 9 shows that the remaining highwall at Middle Creek would have a drop of about 50 feet and a maximum slope of about 13 percent or 0.13. The channel downstream in the absence of any meandering would have an average slope of about 0.008 (42 feet per mile), which is somewhat less than the present slope of Middle Creek valley (0.011) but essentially the same as the slope of the present channel (0.0076). The highwall at Coal Creek also would have a drop of about 50 feet, but a maximum slope of only about 4 percent or 0.04. The channel downstream in the absence of any meandering would have an average slope of about 0.005 (26 feet per mile), which is considerably less than the present slope of Coal Creek valley (0.013) and only about half the slope of the present channel (0.0098).

Thus, the postmining channels of Middle and Coal Creeks would be characterized by (1) an aggrading reach extending upstream from the site of the diversion dam, (2) an oversteepened reach across the highwall, and (3) a flattened reach across the mined area. None of these channel reaches would be in geomorphic equilibrium. In the absence of specific mitigating measures that would control local erosion or induce aggradation, these channels would undergo a generally predictable sequence of changes through natural fluvial processes. Runoff from the respective watersheds entering the aggrading reach upstream from the site of the diversion dams would continue to spread naturally across the aggrading, vegetated valley bottoms. The flow velocity would decrease accordingly, and all but the fine-grained sediments in transport would be deposited. In the absence of the diversion dam, outflow from this aggrading reach then would plunge over the highwall and accelerate to extremely erosive velocities, especially for flows carrying a small sediment load. A vertical overfall or headcut would form at the highwall and migrate rapidly headward, upvalley, cutting a channel through the full thickness of the alluvium underlying the valley floor. Downcutting of the underlying bedrock would also occur, but at a much slower rate. The products of this accelerated channel erosion would be carried over the highwall into the flattened reach downstream where flows would spread across the width of the reclaimed haulroad depression. The decreased depth of flow and consequent decreased velocity would result in depostion of the coarser-grained sediments, forming an alluvial fan. Downstream from this fan meandering would occur, causing some lateral erosion of the adjacent reclaimed slopes. This meandering, however, would further reduce the channel slope and flow velocity; thereby augmenting the deposition of of fine-grained sediments. The tendency over the long term would be to lower the channel profile upstream from the highwall through erosion and to raise the channel profile downstream from the highwall through aggradation until eventually geomorphic equilibrium is reestablished. A different sequence of changes would occur with appropriate mitigating measures. Those changes are discussed under mitigating measures (p. 556 561).

The primary impact to postmining channels in the absence of protective measures would be the erosion of a deep narrow trench or gully upstream from the highwall on Middle and Coal Creek valleys and possibly on other smaller stream valleys terminated by the highwall. These gullies might eventually extend headward appreciable distances and would be the source of large volumes of sediment, a significant part of which might reach the Tongue River Reservoir. The valley trenching, in turn, would cause a significant reduction in plant cover on the dissected valley floors. Aggradation in the reach downstream from the highwall should not significantly impact the environment. The accumulating materials should be no less suitable for plant growth than most soils in the area and should rapidly develop a natural riparian plant cover similar to that on other floodplain deposits in the area. This cover should not be adversely affected by continuing aggradation.

(g) Stability of the reclaimed mine area

Runoff from the reclaimed mine area may be more or less than from the premining terrain, depending on the outcome of the reclamation process. Assuming, however, uniform distribution of a layer of topsoil more than a foot thick, establishment of an acceptable plant cover, and a topography with a poorly developed drainage system, annual runoff from the reclaimed area would probably be reduced as much as 50 percent. If so, erosion and sediment yield should be decreased accordingly. Should establishment of the plant cover be locally unsuccessful, however, or should the plant cover deteriorate in the future for any reason, increased runoff and erosion would be expected, and sediment yields to the Tongue River Reservoir from the mined area might increase to several times the premining rate.

(h) Sediment yield to the Tongue River Reservoir

Because of the many uncertainties associated with the final design, construction, performance, and maintenance of the proposed diversion system in the East Decker area, the outcome of the reclamation plan and the unpredictability of runoff events during the life of the proposed operation, any appraisal of the effect of the proposed mining plan on the sediment yield to the Tongue River Reservoir is necessarily more qualitative than quantitative in nature. Moreover, total sediment yield to the reservoir could vary by several orders of magnitude, depending on (1) the frequency and intensity of runoff events, (2) the use of various mitigating measures, and (3) adequate maintenance of water-control structures and channels. The following estimates are based on specific proposals of the Decker Coal Co. and on the assumption that only the maintenance necessary for efficient operation of the mine would be completed. The reader is referred to pages 556-561 for a discussion of sediment yield to the Tongue River Reservoir in the event that more extensive mitigating measures are adopted.

On that basis, it is estimated that the sediment yield to the reservoir might be reduced as much as 50 percent or about 9 acre-feet annually during the first 5 to 8 years of mining until the settling basin on the Deer Creek diversion channel is filled with sediment. Thereafter, if the settling basin is not cleaned out periodically, the sediment yield to the reservoir would probably increase progressively, depending on the amount of erosion occurring from high flow velocities in the Middle Creek and Coal Creek diversion channels and on the trap efficiency of the settling pond near the outlet of the Coal Creek diversion channel. During the later stages of mining, sediment yield to the reservoir might be somewhat higher than the premining rate. If so, the average rate over the life of the mine might equal or exceed the premining rate. Very little additional sediment should enter the reservoir from the mine area during the period of mining, except as a result of wave erosion along the west embankment of the mine-access road and the railroad spur.

After the proposed mining operations and reclamation measures are completed, the rate of sediment yield to the reservoir probably would increase several fold during the period of channel readjustment in Deer Creek, Middle Creek, and Coal Creek valleys. Eventually, however, these channels should stabilize and the sediment yield to the Tongue River Reservoir should return to approximately the premining rate. Total sediment yield to the reservoir as a result of the mining could be as much as 1,000 acre-feet more than would be expected in the absence of mining. Virtually all of this added sediment probably would be obtained from channel erosion upstream from the highwall. Little or no increased erosion is expected on reclaimed spoil materials within the mined area. Erosion on the reclaimed road and railroad embankments would continue, but at a progressively decreasing rate.

Changes in the rate of sediment yield to the Tongue River Reservoir would be accompanied by changes in areas of sediment accumulation. During the life of the mining operation, deposition would no longer occur within the reservoir basin at the mouths of Deer Creek, Middle Creek, and Coal Creek valleys, because of the diversion of these streams. Deposition would occur instead at the outlets of the Deer Creek and Coal Creek diversion channels (fig. 10) and might adversely impact the fisheries in those areas. On completion of mining, runoff from the Coal Creek watershed would again enter the reservoir at essentially the premining location (fig. 9). Runoff from the Middle Creek watershed would enter the reservoir between the old mouths of Middle Creek and Deer Creek, and runoff from the Deer Creek watershed eventually would follow its premining course to the reservoir.

c. An enlarged Tongue River Reservoir

An appraisal of the impacts of an enlarged reservoir on surface coal mining in the Decker area and vice versa requires an approximation of the relative time frames for initiation and completion of the two projects. The Decker Coal Co. proposes to open the East Decker and North Extension mines as soon as possible (probably in 1977) and to continue operations for a period of about 20 years. No tentative schedule has been set by the Montana Department of Natural Resources and Conservation for initiation or completion of construction on the proposed High Tongue Dam. Funding for this project remains a primary obstacle and introduces considerable doubt that the dam can be completed within the next decade. A definite possibility does exist, however, that a stage I structure (p. 81) may be completed prior to cessation of mining operations in the East Decker area. Moreover, prospects are good that plant facilities and a railroad at the East Decker mine would be used somewhat beyond 20 years in conjunction with future mining activities in the area north and east of the proposed East Decker mine. If so, it appears probable that a stage I structure would be completed while the plant area and railroad are still in use. Completion of a stage II structure (p. 81) is generally considered very unlikely by personnel in the Department of Natural Resources and Conservation until after completion of all surface-mining activities that would be adversely affected by such a project.

(1) Impacts of an enlarged reservoir on the mine

Completion of a stage I dam raising the reservoir spillway to an elevation of 3,438 feet and subsequent impoundment of water to that level would back water into the East Decker area in the absence of protective dikes and would flood an additional 335 acres that are not flooded by the existing reservoir (fig. 21). No part of the actual area to be mined would be submerged, however, because of the protective barrier afforded by the access road and railroad fill, thereby avoiding any direct economic conflicts between the removal of coal and an enlarged stage I reservoir. Nevertheless, an enlarged reservoir would have several impacts on the proposed mining operations in the East Decker area.

At stage I spillway level of 3,438 feet, the reservoir water surface would stand only about 4 feet below the elevation of the plant area, the railroad, and the proposed road and railroad bridges over the Tongue River. Possibly, the mine-access road would be locally submerged. During infrequent major flooding, the reservoir water level may rise several feet above spillway level and, coupled with wave action caused by the prevailing northwesterly winds in this area, would probably flood the plant area, access routes, and railroad. Some flooding might also occur within the active pit in the absence of protective measures, but this threat is considered minimal. Because of the prevailing northwesterly winds, excessive erosion in the absence of riprapping would be expected during most years from wave action against the access-road and railroad-fill embankments.

As all spoil materials used to provide fill for the access road, for the railroad and for the railroad loop and plant area would be placed and moderately compacted by scrapers, these materials should be relatively impermeable (p. 322). Movement of water into and out of these materials in response to fluctuations in reservoir level and the consequent leaching of soluble constituents, therefore, should be inconsequential. The higher water levels associated with a stage I reservoir, however, coupled with the decreased distance between the shoreline and the mine would significantly increase the hydraulic gradient between the reservoir and the bottom of the active pit. The result would be to increase ground-water inflow to the mine, probably by more than 2 ft^3/s.

Completion of a stage II dam raising the reservoir spillway to an elevation of 3,453 feet and impoundment of water to that level prior to completion of all surface-mining activities in the impacted area is not currently regarded as a viable proposal. Should that action be taken, however, the reservoir in the absence of protective dikes would flood an additional 738 acres in the East Decker area that are not flooded by the existing reservoir (fig. 21). The stage II reservoir would submerge the entire plant area and all transportation facilities and would flood the mine through haul-road access routes unless preventative measures are taken. Conceivably, some of the coal resource might be lost in the absence of any protective measures, but that possibility is too remote to be worthy of an evaluation. The new shoreline would impinge directly on spoil embankments, with consequent extreme bank erosion. Should direct flooding of the mine be prevented, ground-water inflow to the mine through the moderately permeable dragline-laid spoils and as a result of the greater hydraulic gradient would probably increase several fold. Consequent leaching of the spoils materials by the greater volumes of inflow would proportionally increase the amount of dissolved solids returned to the reservoir. This impact would be at least partly offset by dilution of solute in the larger reservoir contents.

(2) Impacts of the mined area on an enlarged reservoir

If mining is completed prior to construction of the High Tongue Dam--stage I, the enlarged reservoir would have no impact on mining operations, but the reclaimed area would adversely affect the reservoir and vice versa. The principal impact would be moderate to locally extreme bank erosion where wave action contacts unconsolidated fill materials left by regrading and topsoiling after removal of the mine access road and railroad. A reestablished plant cover would do little or nothing to prevent this type of erosion. Sediment derived from wave erosion would virtually all be deposited within the reservoir basin, with the fine-grained fraction discoloring the reservoir water during and following periods of active bank erosion. Assuming bank erosion of 1 to 2 feet per year, annual sedimentation in the reservoir would be about 10 acre-feet. Bank erosion in the absence of mining in the East Decker area probably would contribute less than 5 acre-feet of sediment annually to the reservoir.

As the reservoir water level rises following completion of the stage I dam, reservoir water initially would enter into ground-water storage in the mine area until the spoils materials are saturated to reservoir level. Thereafter, fluctuations of the reservoir water level or stage would cause periodic ground-water inflow from the reservoir to the mine area during high stage, followed by outflow from the mine area to the reservoir during low stage. Some leaching of the spoils materials would occur. Hydraulic interconnection between the reservoir and the mine area, however, would be generally poor, because the reservoir at stage I spillway level (3,438 feet) would not directly contact the more permeable dragline-laid spoils that comprise the bulk of the fill within the mined-out area. Instead, water must percolate through the relatively impermeable scraper-laid spoils or through the underlying bedrock and the more permeable areas of alluvium and clinker described on pages 323-325. Because of the low hydraulic gradient between the mine area and the reservoir during periods of ground-water inflow and outflow in response to changes in reservoir water levels, the volume of water circulated should be small, probably somewhat less than 100 acre-feet annually. Consequent leaching should be insignificant. Very probably, any appreciable flushing effect on the spoils aquifer from this action would require many hundreds of years. Far greater leaching is expected as a result of raising the level of saturation in the mine area so that ground water moving through the mine area toward the reservoir would contact a greater volume of spoil materials. It should be stressed, however, that the potentially adverse effect of this additional leaching on the quality of water in the reservoir should be more than offset by dilution of the solute in the larger reservoir contents.

Completion of a stage II reservoir and impoundment of water to a spillway elevation of 3,453 feet would incur similar impacts to those described above, but of a significantly greater magnitude. Erosion of spoil embankments and consequent sediment yield to the reservoir would probably pose a major environmental impact that would require protective measures. Once exposed by erosion, the dragline-laid spoils would be in direct hydrologic contact with the reservoir water. Greater leaching of the spoil materials in the mine area would be expected. Very probably, however, the added volume of leachates would be diluted within the larger reservoir contents such that the quality of water in the river downstream would not be measurably different from that discharged from the present reservoir or from a stage I reservoir.

4. Air Quality

The mining of an estimated 6.7 million tons of coal per year at the proposed East Decker mine would create impacts on air quality for the period of active mining. Major potential pollutant emissions within the Decker area caused by the East Decker mining operation are as follows (VTN Colorado, 1975a):

1. Fugitive dust emissions from blasting, removal and disposal of overburden, wind erosion on unvegetated spoil piles, extraction of coal, and traffic on haul roads.
2. Coal dust from coal-processing operations such as conveyor transport, size reduction, and loading operations.
3. Particulates and gaseous emissions from machinery and trucks operating at the mine and from the unit-train transport of coal over the spur line.
4. Indirect source emissions from an increase in the number of motor vehicles traveling to and from the mine site.[1/]

Atomospheric pollutants commonly associated with these emission sources include particulates, carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x) and sulfur oxides (SO_x). Earth and coal dust and other suspended particulate matter generated during the development and utilization of the coal would be the principal air pollutants emitted. If uncontrolled, these emissions would have an adverse impact on the existing ambient air quality in and adjacent to the proposed East Decker coal mine.

[1/] Indirect source is defined as any facility that attracts or is associated with secondary activity which may emit any air pollutant for which there is an ambient air standard.

The estimated uncontrolled emissions from the East Decker mine for an average mining year are summarized in tables 36, 37 and 38. Emission factors for fugitive dust were determined from formulas developed by the Midwest Research Institute (1974) as well as those published by the U.S. Environmental Protection Agency (1973). These values are order of magnitude estimates with no applied control measures. Field observations at similar mining operations indicate that the uncontrolled emission levels predicted may be on the high end of the possible emission-level range. The methods used for determination of uncontrolled emission values are given in Appendix C.

Estimated gross emission values on an uncontrolled basis were determined from the application of emission factors related to the mining operation. These factors were applied to the mining mass-flow rates and data presented in the mining plan and from the description of proposed types of equipment. A discussion of the emission factors and their derivation is presented in Appendix C.

The sources of fugitive dust and other particulate and gaseous emissions are low level or ground level. Except for very calm days, such pollutants should disperse rapidly, and their major impact should be localized in or near the East Decker site. On very calm days, which occur frequently during the fall, and winter pollutant dispersion is retarded to the extent that the local impacts on air quality in the vicinity of the mines would generally be intensified.

Most of the dust generated by the mining activities would consist of relatively large particles that should settle quickly. Very small particles would tend to remain suspended in the air for a longer period. The quantity of such fine-grained dust carried into the air from various operations would depend primarily on the wind. These dust levels are expected to travel only a

Table 36.--Estimated uncontrolled particulate emissions for surface mining of coal at the East Decker mine (modified after VTN Colorado, 1975a)

Mining activity	Estimated fugitive dust or particulates (tons/year)
Topsoil removal	5
Overburden removal	590
Coal extraction	170
Wind erosion of spoil piles	83
Overburden recontouring	150
Topsoil replacement	5
Haulage traffic	740
Coal crushing	335
Coal handling and conveying	2,000

Table 37.--Estimated diesel-exhaust emissions from mine vehicles and equipment at the East Decker mine (modified after VTN Colorado, 1975a)[1]

Pollutant	Diesel truck emissions (tons/year)	Total equipment emissions (tons/year)
Particulates	0.2	0.4
Carbon monoxide	3	6
Hydrocarbons	.5	1
Nitrogen oxides	5	10
Sulfur oxides	.4	.7

Table 38.--Estimated train emissions resulting from coal transport over the spur line at the East Decker mine (modified after VTN Colorado, 1975a)

Pollutant	Estimated emissions (tons/year)
Particulates	9.5
Carbon monoxide	49
Hydrocarbons	36
Nitrogen dioxide	140
Sulfur dioxide	22

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[1] Based on 200-300 hp diesel trucks.

short distance from the source, usually less than a mile, before either settling or dispersing to the point that concentrations become insignificant. There is a potential for the air-pollutant emissions to become trapped in the shallow East Decker basin by surface-based inversions. Such inversions may result in high ground-level concentrations. If these inversions persist for several days, there is a possibility of serious impact on air quality.

A minor potential impact on air quality is that of slack-coal fires. Increased exposure of coal beds to the atmosphere may result in a greater number of spontaneous-combustion coal fires. Such fires could result in short-term visible smoke emissions; but, because of their widely scattered locations and small size, they are not expected to adversely affect visibility in the area.

Also, minor quantities of methane gas would be released from exposed coal beds into the atmosphere. Such emissions should have a negligible impact on air quality because the quantities are very small and are rapidly diluted.

The indirect-source emissions associated with increased motor-vehicle travel resulting from the East Decker mine operation should be minimal. Maintenance and production labor required for operation of the mining facility should, in all probability, not exceed a maximum of 297 employees (table 47). This number of employees, as related to the generated motor-vehicle volumes, is well below the criteria defined by EPA for indirect-source planning.

Relocation of the county road in the East Decker area would cause a short-term decrease in air quality owing to construction activities and heavy-equipment vehicular emissions. The requirements for review of highway projects, as established by EPA serves as an indication of the minor amount of air pollution expected by traffic using the relocated roadway. Projects are reviewed by EPA when the ten year projected traffic is 20,000 vehicles per day. This is about 140 times the traffic expected in twenty years in the East Decker area.

5. Vegetation

a. Existing vegetation destroyed

The most dramatic critical impact on the existing vegetation in the East Decker area would be its destruction by mining. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated. These include: The mining area, areas of highwall, facility sites, haulroads, road relocations, and the railroad spur. In the "associated disturbance" areas, the effects on vegetation would range from total destruction in some areas to relatively minor disturbances in others.

Vegetation diversity, a pattern which reflects differential soil, exposure, and grazing conditions, may be lost for many years after mining. A recent study of land homesteaded and allowed to go back to native range (Olsen, 1973) showed that after 60 years the plant communities on such lands were still significantly different from native communities on adjacent undisturbed lands. On revegetated lands within the East Decker mine area, soil depths and other soil qualities would be more homogeneous than that which existed prior to mining. Accordingly, as plant succession occurs on such areas following the initial reseeding and replanting, vegetative cover would also be more homogeneous.

The competitive advantage of some deep-rooting plants within the East Decker mine area may be lost for many years after mining, thus also affecting plant diversity. Eastern Montana is an area of highly variable precipitation. Deep-rooted plants such as silver sage are found in the drainage bottoms of

Deer and Middle Creeks. Here, deep rooted plants have an advantage during dry years inasmuch as they can tap moisture that is stored at depth in the alluvial soil or possibly moisture that is available because of a "perched" watertable. Such alluvial areas would be destroyed by mining in the East Decker area.

The destruction of vegetation in Deer Creek valley would have significant impacts on the local range and wildlife resources. Destruction would occur when areas of riparian forest are removed during construction of the railroad loop (figure 10) and when mine spoils are wasted into Deer Creek valley (including those spoils used in filling the interior of the railroad loop). Deer Creek vegetation is more important to livestock and wildlife than that of adjacent areas because of its greater productive qualities (see section II.B.5.). Owing to the amount of moisture available in this channel and floodplain area, vegetation vigor and diversity permit heavier grazing and browsing stress than the adjacent areas.

In addition to jeopardizing a food source, the destruction of vegetation would degrade the usefulness of Deer Creek valley as a protected area for wildlife. Pheasants utilize the poplar-willow areas as escape and resting cover. Deer Creek valley also functions as a wildlife travel route to the reservoir as various species take advantage of the protection afforded by the incised valley bottom and dense vegetation. Both mule deer and antelope have been observed in the Deer Creek valley by Department of State Lands staff. Decker Coal Co. personnel show high use by antelope adjacent to the Deer Creek valley on wildlife distribution maps submitted to the Department of State Lands on August 16, 1976.

Because of its moist and in places subirrigated qualities, Deer Creek valley contains a diverse assemblage of grasses, forbs, sedges, shrubs, and trees. The presence of such an area adjacent to the East Decker mine is important to the long-range success of mined-land reclamation. Such success depends not only on the growth and reproduction of those species reseeded by the Company but also on the integrity of plant communities that border the proposed East Decker mine area

b. Impacts on grazing and agriculture

By fencing the proposed mine boundary, approximately 3,715 acres of grazing land representing a livestock carrying capacity of approximately 500 AUM's would be lost for the project's life. Undisturbed vegetation within the proposed mine boundary, much of which is overgrazed today, would benefit, however, from the exclusion of domestic grazing animals for the 20-year life of the project. No agricultural fields (i.e., small grains, alfalfa) exist within the proposed East Decker mine boundaries.

c. Effects of dust on vegetation

Soil and coal dust (air-borne particulates) may influence the undisturbed or reclaimed vegetation in the East Decker area, (dust sources are discussed in section II. A. 5.).

Dust impacts can be separated into three categories (Montana Department of State Lands, 1976b):

1. Dust on leaf surfaces would decrease the amount of light a plant receives, thus decreasing its photosynthetic ability. This decrease would be particularly important during periods when the plant is under stress, such as during seedling establishment, or during drought periods.
2. Accumulation of dust particles on leaf surfaces could reduce the gas-exchange capacity of the cuticle and stomatal apertures. The resulting decline in gaseous

exchange would cause a comparable decrease in the plants photosynthetic capabilities. Also, microscopic airborne particles entering through the stomates, could build to toxic levels, and effectively shut off all photosynthesis.

Dust on a leaf surface also could interfere with digestion of the plant material by cattle. Dust ingested and introduced to the rumen could adversely affect the digestibility of the plant material. There is also the possibility that dust could alter the pH of the rumen, resulting in a change in the rumen flora.

3. Dust could change the microclimate surrounding a plant. Air-borne dust might function as a screen, cutting down on the light received by this plant. Coal dust on or around the plant might have a black-body effect, raising the ambient soil and foliar surface temperatures. Dust also could negatively alter the topsoil in which the plant grows by introducing new chemical constituents. Particulates from overburden and coal may introduce trace elements to the soil and ultimately to the plant. Although unlikely, eventual toxicity could result, particularly from coal dust in which the levels of fluorides and metallic ions are high.

6. Wildlife

a. Mammals and birds

(1) Mule deer

Construction of the railway spur and access road as proposed would disrupt travel patterns and use of the riparian community by mule deer. Construction of rail lines, access roads, plant facilities, and actual mining would remove potential feeding, fawning, resting, and wintering habitat. Increased travel would increase the chances of poaching and deer-vehicle collision losses.

Mule deer are frequently seen within the boundaries of the West Decker mine, and it is probable that this could also happen at the East Decker site. Possible reasons for such sightings are ease of observability, the presence of new, ungrazed grasses and forbs on revegetated mine areas, acclimation of the animals to mine disturbances, and the protection afforded by the prohibition of hunting within the mine areas.

(2) White-tailed deer

Of the three big-game species present in the Decker area, the white-tailed deer is expected to be the least impacted species. The proposed railroad and access road along the Tongue River Reservoir would destroy a small portion of the riparian whitetail habitat. Whitetails are somewhat adaptable to human activity and can easily negotiate fences. The only significant impact would be the increased chance of poaching and deer-vehicle collisions.

(3) Antelope

Antelope would be the most severely impacted big-game species in the East Decker area because mining and associated activity would create a reduction in year-round habitat. Reductions in Decker area antelope populations are likely.

One of the largest groups of antelope (maximum number observed - 35) in the study area would be directly displaced by the East Decker mine. A second group just north of this band would also be dislodged. In addition, the integrity of Deer Creek valley as a fawn-rearing area would be jeopardized by the adjacent human activity, by the placement of the railroad loop, and possibly by spoiling into Deer Creek valley. Lastly, increased travel in the East Decker area would increase the chances of population losses through poaching and antelope-vehicle collisions.

(4) Sage grouse

Of all game species in the study area, the sage grouse would probably be the most severely impacted by mining. These birds would suffer from many activities associated with the mining process, the most significant of which may be the loss of breeding areas. Removal of overburden would destroy a large amount of their food source, and on a short-term basis, a reduction in local sage grouse populations may occur owing to some loss of nesting areas. Sage grouse are intolerant of increased human activity, especially in nesting and wintering areas (VTN Colorado, 1975a). The grouse will endure some increase of activity around strutting grounds, but will abandon such areas during periods of high human activity. Mining would eventually destroy the single identified sage grouse strutting ground within the proposed project area. Birds displaced from this strutting ground would probably establish a new strutting ground or would participate in the breeding activities at other existing grounds in the Decker area.

(5) Sharp-tailed grouse

Little impact is anticipated to sharptail populations in the East Decker area if the East Decker mine application is approved. Sharp-tails are infrequently seen within the East Decker area. The nearest observed dancing ground is located approximately a mile south of the proposed mine site (fig. 55).

(6) Hungarian partridge

Hungarian partridge would suffer little impact because the Decker area provides poor habitat for "Huns" and because most of these birds observed in the vicinity were outside the proposed mine boundary.

(7) Chukar partridge

The covey of about 12 chukar partridge observed along the proposed eastern border of the East Decker mine would be impacted by the mine as proposed. Chukars, which have flexible habitat requirements, probably would either tolerate the mine disturbance or move to undisturbed areas. In either instance, it is doubtful that such a change would be of benefit to the species.

(8) Ring-necked pheasant

Pheasants should only be minimally impacted by construction of the railroad spur, service roads, and by mining activity at the East Decker site. Road and railroad construction would remove a small amount of food and cover from the riparian habitat areas. Pheasants, large, often colorful birds, would also be subject to increased poaching potential.

(9) Great blue heron and double-crested cormorant

The heron and cormorant rookeries are located one eighth to a quarter of a mile east of the proposed East Decker railroad spur (fig. 56). No physical impact on these nesting sites is anticipated. In other areas, herons and cormorants have proved tolerant to levels of activity similar to that proposed for the East Decker area. Mining activity at the West Decker mine has had little effect on those birds currently utilizing the rookery.

(10) Geese, ducks, and shore birds

Construction of the railroad spur and access road would disturb the riparian habitat locally along the banks of the Tongue River and would thus impact nesting habitat for waterfowl in the East Decker area. It is not known whether geese nesting in the heron and cormorant rookeries and along the eastern shore of the Tongue River Reservoir would tolerate mine-related activities.

As with geese, it is also not known whether ducks and shore birds nesting along the eastern shore of the reservoir would be negatively impacted by railroad construction.

Hunting pressure on waterfowl utilizing the Tongue River Reservoir may decline because mine-safety requirements permit no hunting within the mine areas.

(11) Osprey

Known osprey nesting in the East Decker area is limited to one nest located about 200 feet west of the proposed railroad alignment. Montana Department of Natural Resources and Conservation (1976) reports that the degree to which the construction and operation of the proposed railroad would impact the osprey is subject to speculation:

> "There are instances of osprey nesting on power poles near or immediately adjacent to active railroad and highways. Obviously, these are birds which have become habituated to some disturbance. Whether the nesting osprey at Tongue Reservoir will remain once construction begins is unknown. A great deal depends upon the nature and temperment of the particular birds, the timing and extent of the construction activity, and whether the young are present when the construction commences (once young are present, the osprey will tolerate greater disturbance). The fact that these birds are accustomed to some disturbance (existing mine and county road) and rebuilt their nest four times (after it was blown from the tree) gives some indication that they are determined to nest in the area. Nevertheless, any new activity, such as that which is proposed, may well lead to their abandoning the nesting site, if not the area."

(12) Bald eagle

Increased activity at the West Decker mine to date has not caused discernable impacts on bald eagles wintering in the area. Similar to observations in other wintering areas, the eagles have become habituated to this disturbance by man (Montana Department of Natural Resources and Conservation, 1976), and there is no evidence to suggest that either the building of the railroad spur or the proposed mining operation would alter their use of the area. Construction of powerlines might increase accidental death through electrocutions and collisions, and mining would cause some loss of available feeding areas.

(13) Golden eagle

The golden eagle is not expected to suffer extensively from the proposed coal mining at East Decker. Accidental deaths may increase from construction of powerlines, and mining would remove small portions of available hunting areas. No nests are known to exist around the area, so no impact on nesting sites would occur.

(14) Turkey vulture

No significant impact to the turkey vultures using the East Decker and adjacent areas is anticipated. If construction or mining activity were to disrupt use of the roost tree north of the proposed loop, it is felt that the birds could readily relocate (Montana Department of Natural Resources and Conservation, 1976).

(15) Nongame birds and mammals

Nongame species would be impacted primarily by the loss of habitat. During the mining process, several hundred acres of small-mammal habitat would be destroyed as overburden material is removed, leading to a decline of small mammals or primary-consumer populations. Animals most affected by habitat loss include the western deer mouse, mountain cottontail, white-tailed jackrabbit, Richardson's ground squirrel, black-tailed prairie dog, sagebrush vole, northern pocket gopher, and Ord's kangaroo rat. Animals least affected would be those existing primarily in plant-community types not present in the actual mining area. These include animals associated with the ponderosa-pine badlands. These animals may suffer increased population losses as a result of the increased hunting pressures exerted by secondary consumers when primary consumers in the mining area are no longer available as a food source (VTN Colorado, 1975a).

Mine operations will decrease available nesting and feeding areas for many of the resident song and insectivorous birds. The density of breeding birds within the proposed mining area does not appear to be heavy.

b. Fish

The fisheries of the Tongue River Reservoir could be negatively impacted if mining at the proposed East Decker site causes substantial changes in reservoir water quality and sediment load. Sodium is an element of particular concern because it is toxic to fish in high concentrations and may also be toxic at lower concentrations when mixed with other elements (Montana Department of Natural Resources and Conservation, 1976). Increased sodium or other chemical levels in the reservoir could result, though it is not expected, from the leaching of East Decker mine spoils or from mine-water discharge into the reservoir (see discussion of impacts on water resouces, p. 443-447). Increased dissolved-solids concentrations in reservoir waters may also result from the leaching of railroad-fill material placed at or below high-water level (Montana Department of Natural Resources and Conservation, 1976). Increased sodium levels measured during the summer of 1975 as a result of reservoir drawdown were found to have no observable fishery impact.

If a substantial increase in reservoir sedimentation were to occur as a result of mining in the East Decker area, fish productivity may decline as a result of the burial and smothering of "incubating" fish eggs. Food sources (i.e., benthic invertebrates, etc.) could also be covered in those areas where reservoir sedimentation occurs.

In addition to diverting Deer Creek, East Decker mining plans indicate that Coal and Middle Creeks would be intercepted and diverted. As all three of these streams are ephemeral, no fisheries exist within the proposed mine boundaries.

Changes in reservoir operation owing to the loss of storage could cause low reservoir levels during periods critical to the fishery. This effect would be minimal if mine development is precluded from the Deer Creek floodplain (Montana Department of Natural Resources, 1976).

Increased recreational demand resulting from Decker area mine development (fishing, hunting, boating, etc.) is expected to have little impact on the fishery resource of the Tongue River Reservoir.

7. Archaeological and historical sites

Archaeological sites identified in the proposed East Decker project area would be largely eliminated by mining and associated activities. Fredlund (1976) identified two sites within the project area and four sites outside the project area, but within the East Decker survey area (fig. 63A). Lahren (written communication, December 3, 1976) subsequently identified an additional four sites within the East Decker project area. None of Fredlund's or Lahren's sites is currently listed in the National Register of Historic Places (Ken Korte, State Historic Preservation Officer, written communication, February 4, 1977). Lahren has recommended, however, that one of his sites (24BHB14) be tested to determine its eligibility for inclusion in the National Register (Larry Lahren, written communication, December 3, 1976).

Given the number of sites discovered by Fredlund and Lahren, prospects are good that additional sites not recognized in either survey would be destroyed by mining in the East Decker area. Thus the possibility exists that a significant undiscovered archaeological site may be inadvertently destroyed.

Professional differences of opinion as to what should constitute an archaeological site appears to be partly responsible for the additional site locations that Lahren identified following completion of Fredlund's study.[1/] Furthermore, total recovery of all sites on large tracts of land is very difficult and probably would not be necessary to adequately inventory and appraise the archaeological resources of the East Decker area. Fredlund's discovery of sites in the East Decker area may have been seriously hindered by the exceptionally dense plant cover during the period when the survey was conducted. Abnormal plant growth occurred in response to above normal precipitation in the area during the previous year.

All six sites identified by Fredlund in the East Decker survey area were sketch mapped, collected, and photographed. Power augering was used as a subsurface evaluation technique in areas having subsurface archaeological site potential. Augering failed to reveal any presence of buried artifacts. Accordingly, Fredlund recommended that no further appraisal was necessary for any of these sites.

The disturbance of these sites by mining, therefore, should have minimal impacts on man's understanding of the Decker area cultural resources inasmuch as each site has been properly recorded and evaluated. All important artifacts have been salvaged and preserved.

Conversely, the four sites identified by Lahren in the East Decker area were only observed, except for the collection of one projectile point fragment (table 33B). Should mining disturb these sites prior to appropriate study and recovery of artifacts, significant archaeological resources could be lost. Of particular importance is site 24BHB14, which is described as a collection of

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[1/] Archaeological site definitions and survey standards related to Fredlund's and Lahren's work in the Decker area are discussed on pages 613-614 and in Appendices H and I.

rock cairns, stone circles, and rock drive lines that possibly lead to a bison-kill site. This is the site that Lahren has recommended for testing to determine its eligibility for inclusion in the National Register.

No structures or ruins within the East Decker project area are listed in the National Register of Historic Places, nor has any structure or ruin within the area been so nominated. In addition to those structures described by Murray (1975), a group of foundations and ruins adjacent to the east shore of the Tongue River Reservoir have been identified by Lahren. These structures probably have no historical or architectural significance; however, a potential loss of cultural data remains until these structures are adequately described, photographed, and appraised.

8. Recreational facilities and activities in the Decker area

Decker Coal Co.'s proposed East Decker mine would exclude all lands within its boundaries from recreational use. Adjacent lands, therefore, may be subjected to slightly greater utilization pressures owing to this decline in available land area. Increased use of the existing recreation facilities adjacent to the Tongue River Reservoir would occur because of the influx of people into the Decker area in conjunction with mining activities. These facilities are currently in poor condition and of somewhat limited capacity. The proposed East Decker mine might result in use beyond tolerances, thus resulting in land disturbance, destruction of private property, and possible pollution and littering problems in areas of increased use. Human interaction problems may also arise from the increased congestion in recreation facilities.

The East Decker mine would also have aesthetic impacts on recreationists using the Tongue River Reservoir and the Tongue River Recreation Area (fig. 63A). East Decker spoil piles, load out facilities, etc. would be visible from many portions of the reservoir and adjacent shoreline. Similarly, dust clouds, in particular those associated with blasting, would frequently be visible in the Decker area. In addition to visible aesthetic impacts, such audible activities as blasting and coal crushing could negatively impact the recreational pleasure of reservoir and recreation area users.

Hunting pressure in the Decker area and the resultant impacts on wildlife populations should not substantially change when compared to present conditions. Increased human activity in the vicinity, however, would probably result in an increase in poaching and accidental vehicle-caused deaths for some species, especially deer and antelope.

9. Aesthetics

Loss of vegetation and wildlife, coupled with landform degradation and the location of spoil banks, loading equipment, the railroad spur buildings, and coal-processing equipment would detract from the aesthetic attributes of the area. This may be especially true for those people that use the Tongue River Reservoir for recreation purposes (see section III. A. 8. above). Potentially, the loss of air quality and any increases in ambient noise levels could severely degrade the sense of peace and tranquility now present in the East Decker area. General increases in human activity and demands brought about by this increased population could potentially impact the aesthetic environment well beyond the proposed mine boundaries. However, it is not possible to determine the severity of this impact at present. (VTN Colorado, 1975b).

10. Public and access roadways

The primary impact of relocating a section of the county road (p. 46) would be the loss of approximately 34.9 acres of moderately dry grassland interspersed with isolated pockets of ponderosa pine. Grazable acreage and wildlife habitat would subsequently be reduced.

While a short-term decrease in air quality would occur from construction activities and heavy-equipment vehicular emissions, the relocation would not have a significant effect on the project area's air quality. The requirements established by EPA for review of highway projects are an indication of the minor amount of air pollution that would be caused by traffic using the relocated section. Projects are reviewed by EPA when the ten-year projected traffic is 20,000 vehicles per day. This is about 140 times the traffic expected on the county road in twenty years. The relocation would not be in conflict with the State's Implementation Plan for achieving Federal ambient air-quality standards.

Provided that Big Horn County requires the applicant to adhere to all applicable State and Federal laws regarding water pollution, the relocation would cause only a short-term decrease in water quality. Such a decrease would be caused by increased erosion and sedimentation resulting from road-construction activities.

Relocation of people, dwellings, or businesses would not occur, nor would the county-road relocation take land from a publicly-owned park, recreation area, or wildlife/waterfowl refuge of local, state, or national significance. No known historic or archaeological sites exist within the proposed county-road relocation route.

A noise analysis using the nomograph method indicates that noise caused by projected traffic of 140 vehicles per day traveling at 50 miles per hour, with 12 percent of all vehicles being trucks, would be within the acceptable design noise level of L_{10}70 dBA.

11. Train traffic

At full production of approximately 6.7 million tons of coal annually from the East Decker mine, a total of about 26 unit trains, 13 loaded and 13 empty, would traverse the East Decker spur line each week. These trains would obstruct traffic at the county road crossing on the west side of the Tongue River, (fig. 10) but would not cross, and therefore, would not impede traffic flow on Route FAS 314.

Impacts to county road users include (1) the inconvenience of occasional delays to normal farm-to-market traffic, mail-delivery vehicles, and school buses; (2) the more serious possible interference with emergency vehicles such as fire-fighting equipment, ambulances, or other vehicles used in emergency situations; and (3) the hazard posed by train-vehicle collisions at the road crossing.

Data furnished by the Burlington Northern Co. (Montana Department of Highways, written communication, December 29, 1976) indicate that, under normal rail-traffic conditions, a loaded unit train (100 cars, each carrying 100 tons) will block a road crossing and obstruct any traffic for a period of about seven minutes; an empty train normally blocks a crossing for a period of only about four minutes. Accordingly, unit-train traffic to and from the East Decker mine at full production can be expected to block the crossing on the county road for approximately 20 minutes during each 24 hour period. It should be noted, however, that equipment breakdowns and other problems may cause occasional traffic delays considerably in excess of 20 minutes (p. 438).

B. North Extension mine

1. Topography

The proposed reclaimed surface in the North Extension area (fig. 19) would contain no closed depressions that would impound surface runoff and require special mitigating measures. Dominant features of the reclaimed topography would be (1) two elongate north-trending ridges along the eastern margin of the mined area, one in the western part of sec. 34, T. 8 S., R. 40 E., and one near the center of sec. 3. T. 9 S., R. 40 E., (2) an elongate depression along the western margin of the mined area, and (3) an east-trending depression through which all surface runoff from the watersheds to the west would drain to the Tongue River Reservoir.

The two elongate, north-trending ridges on the east margin of the mined area would be formed by reclaimed spoil materials excavated from the initial box cuts. The northern ridge in sec. 34 would be about a mile long, 500 to 750 feet wide at the base and 40 to 60 feet high. The southern ridge in sec. 3 would be about 1.3 miles long, 400 to 700 feet wide at the base and 40 to 100 feet high. Side slopes facing the Tongue River Reservoir would be moderately steep, averaging 15 to 20 percent. Slopes of this magnitude would be subject to sheet and rill erosion unless they are protected by a good plant cover and appropriate land-treatment practices.

The elongate depression along the western margin of the mined area would be left by the final cut at the base of the highwall. Although reduction of the slope of the highwall and burial of any exposed coal beds, as required by State law, would partially fill this cut, the final depression would be 2.8 miles long, 500 to 1,000 feet wide at the top and 50 to 100 feet deep. Side slopes would average 20 to 25 percent and locally would approach the maximum allowable slope of 20 degrees (36 percent). Slopes of this magnitude would be subject to excessive sheet and rill erosion unless they are protected by a good plant cover and appropriate land-treatment practices.

Pearson Creek valley would not be retained as a topographic feature of the reclaimed surface. Instead, runoff from the Pearson Creek watershed would flow over the highwall into the depression left by the final cut and then generally northward along the bottom of the depression to become a permanent tributary of Spring Creek. Spring Creek and South Fork Spring Creek would also enter the reclaimed final cut over the highwall and, together with the runoff from the Pearson Creek watershed, would drain generally eastward approximately following the premining course of Spring Creek across the mined area. Because of the elimination of the lower reaches of Pearson Creek valley and the creation of a potentially unstable, eroding surface characterized by prominent ridges on the east margin of the mined area and an elongate depression on the west margin of the mined area, the proposed reclamation plan would not approximately restore the original surface configuration.

2. Soils

Mining in the North Extension area would result in the disturbance and mixing of the topsoil on approximately 1,340 acres. This disturbance would alter climate-soil-plant relationships established during recent geologic time. Moreover, off-road vehicle use might seriously disturb soils in areas adjacent to the mine.

Most impacts stemming from soil disturbances in the North Extension area are essentially the same as those described for the East Decker area (section III. A. 2.). The reader also is referred to section III. B. 3. b. (5) for a discussion of erosion and sedimentation as a consequence of mining in the North Extension area.

As in the East Decker area, principal impacts would be:

1. Removal and replacement of salvable topsoil resulting in generally unfavorable changes in physical, chemical, and biological characteristics. Erratic mixing of the A, B, and C horizons would cause a loss of soil structure, decreased porosity and permeability, and increased bulk density.
2. Replaced soils would have significantly less organic content and biological activity in their upper part compared to undisturbed soils in the area.
3. Burial of plants, plant propagules, and seeds normally found in the upper part of the soil profile would reduce the potential for regeneration of native plant species.
4. Soil disturbances and changes in surface configuration would tend to eliminate the ecologically distinct plant communities that currently exist in the area and produce a more uniform postmining plant cover.
5. Removal of salvable soil materials in advance of mining would expose the denuded areas to accelerated erosion by wind and water, causing local air pollution and possibly some increase sediment yield to the Tongue River Reservoir.

6. Stockpiled soil materials would be depleted by erosion unless adequately protected and would undergo a significant reduction in biological activity if stored for long periods.
7. Replaced topsoil would be subject to accelerated erosion until an adequate protective plant cover is established. The predominantly silt- and sandy-loam soils in the North Extension area are especially vulnerable to erosion by both wind and water.
8. Prolonged erosion and consequent loss of the replaced topsoil on the steeper slopes might occur if establishment of an adequate protective plant cover takes longer than anticipated. Such erosion might initiate rills and gullies that could migrate headward upslope. Soil depth would be reduced on eroding areas and increased in aggrading areas.
9. Soil slippage with consequent impacts on the plant cover and slope stability may occur if replaced topsoils are not properly bonded to the graded spoil surface.
10. If reclamation is unsuccessful, the utility of the soils would have been relinquished in part for coal production.
11. Burial within 8 feet of the surface of high-sodic spoil materials obtained from below the upper-most coal bed could cause sodic-soils problems. Sodium-induced soil crusting and reduced permeability would increase local runoff and erosion and decrease soil moisture for plant growth.

Impacts from soil disturbances that differ from those in the East Decker area are:

1. Local sodic-soils problems could be introduced by salvaging Tensleep silt loam; Kim loam, or Nevee silt loam (mapping units 1, 6, and 16, fig. 37) for use as topsoil during reclamation. The moderately high SAR values of these soil phases tends to discourage their use as topsoil. The single overburden sample from the northern part of the North Extension area also indicates a possible sodic-soils problem in that part of the area.
2. Although unlikely because of the preponderance of clinker in the North Extension area, additional detailed soil and overburden sampling in the northern and western parts of the proposed mine area might reveal a local sodic-soils problem.
3. Construction of relocated Route FAS 314 along the west side of the Tongue River Reservoir (fig. 20) would introduce impacts very similar to those stemming from construction of the railroad spur along the east side of the reservoir in the East Decker area. Consequent erosion of disturbed areas by wind and water and resultant air pollution and sediment yield to the reservoir would be short term.

3. Water resources

a. Effects on ground water

Surface mining of coal in the North Extension area would adversely affect the hydrologic system in the same general way as the proposed mining operations in the East Decker area. The net results, however, would be considerably different owing to the fact that the overburden in the North Extension area is comprised largely of highly permeable beds of clinker as much as 135 feet thick. These permeable materials can and do transmit large quantities of ground water that must be dealt with, thereby magnifying the hydrologic impacts of mining. To facilitate comparison of the impacts of mining in the two areas, the following headings are the same as those used for the East Decker area.

(1) Removal of parts of certain aquifers

An unavoidable impact of surface mining in the North Extension area would be the removal of parts of certain aquifers. Aquifers that would be adversely affected include beds of clinker, deposits of alluvium in Spring and Pearson Creek valleys, the unburned remnants of the combined Anderson-Dietz 1 coal, and the Dietz 2 coal. These aquifers would be completely removed within the limits of the mine area; beyond these limits, the aquifers would remain intact. The approximate areal extent of aquifers that would be removed is as follows:

Aquifer	Approximate area to be removed (mi^2)
Clinker	1.5
Alluvium	.5
Anderson-Dietz 1 coal	1
Dietz 2 coal	2

Those parts of aquifers that are removed would be replaced by a single aquifer composed largely of clinker and alluvial materials. The effect of this change on the quantity and the quality of the ground-water supply after mining can be inferred from the changes in aquifer properties that would occur. The volume of ground water in storage probably would increase appreciably within the reclaimed area owing to the additional void space incorporated in the spoil aquifer. This enlargement of the ground-water reservoir would not necessarily increase the long-term supply of ground water, but it would provide additional storage to support increased seasonal withdrawals from wells. The effects of leaching of the spoil materials on water quality are discussed in section III. B. 3. a. (4).

(2) Interruption of ground-water flow by the pit

Excavation of the two proposed box cuts in the North Extension area would intercept most ground-water flow through the area toward the Tongue River Reservoir. In addition, dewatering of the strip pits would reverse the pre-mining ground-water gradient between the mine area and the reservoir, thereby inducing ground-water flow from the reservoir into the mine. Upward leakage from the Canyon coal bed, which would not be disturbed by mining, is expected to be nil. Similarly, contributions of water to the mine from underflow through the alluvium underlying Pearson and Spring Creeks is expected to be small. There is, however, a large volume of ground water in storage below the level of saturation in the clinker materials, which are intricately fractured and highly permeable. Thus, inflow of ground water to the strip pits would consist essentially of three components; (1) ground-water inflow from the west, representing ground-water discharge from the watershed, (2) ground-water inflow from the east, supplied by the Tongue River Reservoir and (3) ground water released from storage in the clinker.

Estimated rates of inflow to the North Extension mine are given in table 39. These estimates were necessarily based in part on several simplifying assumptions. The results reported in table 39 should be regarded generally as an indication of the order of magnitude rather than an estimate of the actual probable rates of ground-water inflow to the mine.

Table 39.--Estimated inflow of ground water during and after construction of the initial box cuts in the proposed North Extension mine

Elapsed time from start of construction (days)	Length of box cut (feet)	Estimated inflow							
		From Tongue River Reservoir (ft^3/s)		From aquifer discharge (ft^3/s)		From aquifer storage (ft^3/s)		Total (ft^3/s)	
		Low	High	Low	High	Low	High	Low	High
				SOUTHERN BOX CUT					
10	200	---	---	---	---	2.5	3.2	2.5	3.2
50	1,000	.1	.4	.3	.4	1.9	2.2	2.3	3.0
90	2,500	.4	.7	.6	.8	2.8	3.3	3.8	4.8
130	3,200	1.0	1.6	.9	1.2	1.8	1.9	3.7	4.7
210	6,100	3.3	4.6	1.4	1.8	1.2	1.2	5.9	7.6
230	6,600	4.2	5.8	1.5	2.0	1.3	1.4	7.0	9.2
595[1/]	6,600	4.5	6.0	1.5	2.0	.3	.4	6.3	8.4
1,825[2/]	6,600	4.5	6.0	1.5	2.0	.2	.2	6.2	8.2
				NORTHERN BOX CUT					
10	200	---	---	---	---	0.2	0.4	0.2	0.4
15	300	---	---	<0.1	<0.1	.7	.9	.7	1.0
90	2,500	---	---	.8	1.2	1.8	2.1	2.6	3.3
120	3,500	<0.1	0.1	.9	1.3	1.5	1.7	2.4	3.1
160	4,900	.1	.2	.9	1.3	1.4	1.6	2.4	3.0
180	5,300	.1	.2	.9	1.3	1.3	1.4	2.3	2.9
545[1/]	5,300	.3	.4	.9	1.3	.4	.4	1.5	2.0
1,825[2/]	5,300	.3	.4	.9	1.3	.2	.2	1.3	1.8

[1/] One year after completion of initial box cut.

[2/] Five years after start of initial box cut.

Computations indicate that total inflow to the mine on completion of the southern box cut through section 3 and the northern part of section 10 (fig. 13) should range from about 7.0 to 9.2 ft^3/s (3,140 to 4,130 gal/min). About 15 to 20 percent of this water would come from ground-water storage; the other 80 to 85 percent would come from ground-water flow through the clinker from the recharge area to the west and from the reservoir to the east. The amount of ground water released from storage would tend to decrease progressively with time, but water moving through the clinker from the east and west probably would remain comparatively constant over the life of the mine, excluding seasonal fluctuations.

The rate of ground-water flow through the clinker from the recharge area to the west is estimated to range from about 1.5 to 2.0 ft^3/s (675 to 900 gal/min) (table 39). This rate of flow is controlled by the amount of annual ground-water recharge that occurs in the watersheds of Spring and Pearson Creeks and possibly may fluctuate with time in response to climatic cycles. In contrast, inflow from the east or reservoir side of the pit would be controlled largely by reservoir water levels and can be expected to fluctuate seasonally as the reservoir alternately is filled and emptied. Hence, wherever the highly permeable clinker is exposed in the mine below reservoir stage, the clinker would act as a pipeline, carrying water from the reservoir into the mine. The general areas where the base of the clinker occurs below elevations of 3,420 and 3,400 feet are shown in figure 64. Locally within this area, the bottom of the clinker is as much as 40 feet below the spillway elevation of the reservoir.

Inflow of ground water from the reservoir through the clinker into the southern box cut is estimated to be about 4.5 to 6.0 ft^3/s (2,000 to 2,700 gal/min). The actual amount would be proportional to the hydraulic gradient between the reservoir and the mine and to the width, thickness, and permeability of saturated clinker exposed in the mine. The gradient would be steepest in those areas where the mine is closest to the reservoir and where the bottom of the clinker is exposed at the lowest elevation in the mine. Thus, dewatering the southern box cut (fig. 64) should induce most inflow from the reservoir in the northern part of the pit where the mine is closest to the reservoir and the saturated thickness of the clinker is more than 20 feet. Most inflow to the southern part of the pit probably would be derived initially from ground-water storage in the clinker. It should be noted, however, that the above estimates are based on an assumed uniform hydraulic conductivity (permeability) of 150-200 ft/day (see Appendix D for calculations of flow rates). Should the pit intersect fused areas of clinker in which the rock resembles porous lava (p. 125) and contains elongate tubular openings that are in hydraulic connection with the nearby reservoir, inflow to the mine could be at a much higher rate than that shown in table 39.

Similarly, computations indicate that inflow to the northern box cut, upon its completion, would probably range from 2.3 to 2.9 ft^3/s (1,000 to 1,300 gal/min) (table 39). About half of this flow would be derived from ground water moving through the clinker from the recharge area to west and from the reservoir to the east; the other half would be derived from storage in the clinker. Flow through the clinker from the recharge area and from the reservoir is expected to fluctuate seasonally, but should not diminish appreciably during the life of the mine. Inflow to the mine from ground-water storage probably would decrease progressively as mining continues westward and may eventually cease entirely. Hence, in the late stages of mining the inflow to the northern pit might be reduced from 1.1 to 1.6 ft^3/s (500 to 700 gal/min).

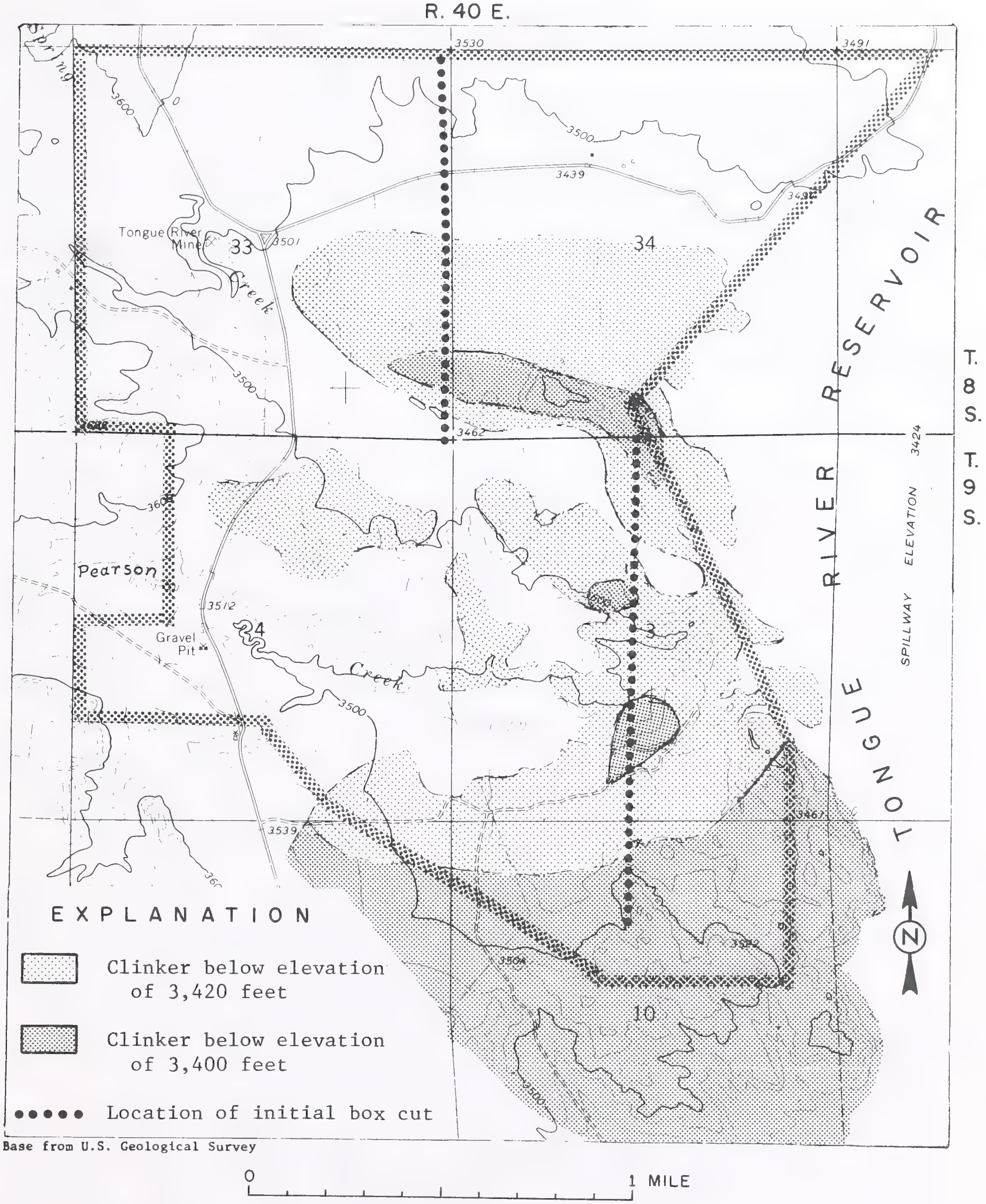

Figure 64.-Map of the North Extension area showing where the bottom of the clinker occurs below the normal level of the Tongue River Reservoir.

(3) Modifications of ground-water flow by replaced spoil materials

Replacement of spoil in the mined-out area between the active pit and the Tongue River Reservoir to the east is expected to have little effect on the rates of inflow of ground water to the North Extension mine from the reservoir. This tentative conclusion is based on the assumption that spoil derived largely from clinker would probably be more permeable than the undisturbed clinker. Conceivably, the mixture of interburden and clinker, which would form the spoil, might introduce some local modifications in the vertical and horizontal directions of ground-water flow. The primary direction of movement, however, should reflect the direction of maximum hydraulic gradient through the reclaimed area.

The major impact of the replaced spoil materials on the flow of ground water would occur after mining has ended and pumping to dewater the mine is discontinued. At that time outflow of mine effluent water to the Tongue River Reservoir would cease, but inflow to the mined-out area from the watershed to the west and from the reservoir to the east would continue until the spoil materials are saturated to reservoir level. Thereafter, inflow from the reservoir would generally cease and the premining gradient across the mined-out area toward the reservoir eventually would be reestablished. Depending on the volume of pore space that must be filled in the spoil materials and the rate of inflow to the mine area, it may take several years to reestablish the premining gradient. During most of that time, the Tongue River Reservoir would contribute water to the mined-out area. Initially, seepage from the reservoir might be as much as 10 to 20 acre-ft/day. This amount would diminish progressively with time, however, until ground-water discharge from the mined-out area to the reservoir is resumed. Thereafter, the rate of ground-water discharge to the reservoir would increase progressively until it reaches essentially the premining rate of about 5 to 7 acre-ft/ day.

(4) Changes in water quality caused by leaching of spoil materials

As ground water accumulates in the replaced spoil after pumping is discontinued, solution and interaction with soluble minerals in the spoil materials would change the quality of the ground water. Although definitive analytical data are lacking from which to predict the effects of this leaching on water quality, some inferences can be drawn from knowledge of the chemical character of ground water that has been in contact with the materials that will eventually comprise the spoil.

The bulk of the spoil material in the North Extension area would be composed of clinker, which is practically inert to leaching by ground water. However, the spoil would also contain an admixture of sandstone, siltstone and shale obtained from the interburden between the Anderson-Dietz 1 coal bed and the underlying Dietz 2 coal bed. Unlike the clinker, this material appparently contains appreciable amounts of soluble solids that could be leached by ground water. Water obtained from wells tapping sandstone aquifers in the interburden and overburden materials is generally highly mineralized (table D-1, Appendix D). Thus, ground water moving through the mined area can be expected to increase in dissolved-solids content to the extent that this water comes in contact with the leachable interburden materials. Principal ions to be leached from the interburden materials are sodium and sulfate.

The adverse effects of leaching of spoil materials on the quality of ground water in the North Extension area are not expected to be as severe as in the East Decker area because of (1) the limited quantity of leachable material in the spoil and (2) dilution resulting from the larger volume of ground water moving through the mined-out area. During mining, some leaching near the base of the spoils materials may occur as ground water moving from the reservoir toward the pit contacts the lower part of the replaced spoil. Accordingly, effluent water pumped from the mine proably would show some increase in dissolved-solids content and sodium-adsorption ratio as mining progresses westward and the width of spoils interposed between the reservoir and the active pit increases. The consequent change in water quality, however, should be small and should not significantly affect the utility of the water supply or measurably degrade the quality of water in the Tongue River Reservoir. The effects of leaching in the North Extension area probably would not become evident until mining is discontinued and the level of saturation in the reclaimed spoil materials approaches the premining level. At that time, ground water would be in contact with a comparatively large volume of spoil materials, and the residence time of the ground water in the spoil would be significantly increased.

Mining in the North Extension area is expected to increase the dissolved-solids content of ground water moving through the area and discharging to the Tongue River Reservoir from about 1,500 mg/1 before mining to about 2,000 mg/1 after mining. Similarly, the sodium-adsorption ratio probably would increase from less than five to about ten. Effects of this change in water quality on the Tongue River Reservoir are described in section III. C. 3. a. (5).

(5) Effects of blasting

The use of explosives in the North Extension area should be considerably less than in the existing West Decker and the proposed East Decker mines because of the extent of fracturing in the clinker. Repeated blasting to loosen the interburden and the coal during mining operations in the North Extension area, however, would generate a series of small seismic shock waves. Although these shock waves should be rapidly dissipated by surrounding earth materials, the seismic effects may produce some objectionable turbidity in nearby wells. The reported effects of blasting in the existing West Decker mine on Emmett Munson's well in sec. 22, T. 9 S., R. 40 E., are described on p. 330.

In addition to the seismic effects, the use of nitrate explosives in the mine probably would introduce some nitrogenous compounds into the spoil. These compounds subsequently could be leached by ground water and added to the mine effluent. Van Voast and Hedges (1975, p. 15) report sporadic oocurrences of up to 110 mg/1 of nitrate in the effluent from the West Decker mine. Unusual occurrences of nitrate in ground water in the West Decker area, however, are not restricted wholly to mine effluent. A few high nitrate concentrations have been noted in water from privately owned wells upgradient from the West Decker mine (Van Voast and Hedges, 1975, table 3).

(6) Changes in water levels

During operation of the North Extension mine, pumping to dewater the active pits would lower the hydrostatic head in each of the aquifers exposed in the mine. As this occurs, water levels in nearby wells would decline. The amount of decline in any given well depends on several factors. In general, the largest declines are expected in wells completed in the lowermost confined aquifer exposed by mining; conversely, the smallest declines should occur in wells completed in the shallow unconfined aquifers, such as alluvium and clinker. Within each aquifer, water-level declines would be greatest in wells nearest the active pits and would diminish progressively with increasing distance from the pits.

Greatest water-level declines in the North Extension area probably would occur in wells completed in the Dietz 2 coal bed. Declines in these wells adjacent to the mine area should range from 40 to 70 feet. A few thousand feet away from the margin of the mined-out area, however, water-level declines in wells completed in the Dietz 2 coal probably would range from 20 to 30 feet. At a distance of a mile, declines probably would be less than 10 feet.

Wells tapping overlying aquifers such as the Anderson-Dietz 1 coal or clinker should experience declines ranging from about 40 feet near the margins of the mined-out area to less than 10 feet at a distance of more than half a mile from the mine. Changes in water levels in and near the North Extension area during mining could possibly affect a total of 12 existing wells, 8 of which are currently being used as a source of water supply. Included in this group are the following wells:

No.[1]	Location T., R., Section	Owner
21	8 S., 40 E., 32 DAAD	Decker Coal Co.
22	8 S., 40 E., 32 ACDB	do
23	8 S., 40 E., 33 BCDA	do
24[2]	8 S., 40 E., 34 BDAA	do
25	8 S., 40 E., 34 BDAA	do
26[2]	8 S., 40 E., 34 BDBA	do
43	9 S., 40 E., 3 ACAB	do
44	9 S., 40 E., 3 CCCD	do
45[2]	9 S., 40 E., 3 CDCD	do
46[2]	9 S., 40 E., 3 DCAB	do
47	9 S., 40 E., 4 CDAB	do
48	9 S., 40 E., 5 BACD	do

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[1] Sequential number of well (see listing in table D-1, Appendix D).

[2] Well not used.

Five of these wells (nos. 22, 23, 44, 45, and 47) lie within the area to be mined and would be physically destroyed. Two others (nos. 21 and 26) would be rendered useless or seriously impaired because of excessive declines in water levels as a consequence of mining. The remaining five wells (nos. 24, 25, 43, 46, and 48) should be only minimally affected; the use of these wells probably would not be impaired.

In addition to the 12 wells, there are 5 springs within or near the North Extension area (fig. 43) that could be adversely affected by changes in water levels during mining. The number, location, and ownership of these springs are as follows:

No.[1]	Location T., R., Section	Owner
2	8 S., 40 E., 33 CBDB	Decker Coal Co.
3	8 S., 40 E., 34 ACCA	do
4	8 S., 40 E., 34 DAAA	do
5	9 S., 40 E., 3 DABB	do
6	9 S., 40 E., 11 BBBD	do

[1] Sequential number of spring (see listing in table D-5, Appendix D).

One of these springs (no. 2) would be eliminated, because it lies within the area to be mined. Two others (nos. 5 and 6) probably would stop flowing during the period of mining because the water discharging from these springs probably would be intercepted by the strip pit. The remaining two springs (nos. 3 and 4) should not be impaired by the operation of the mine.

b. Effects on surface water

Impacts of the proposed mining plan on surface water in the North Extension area include: Removal of all existing stream channels within the area mined; interception and diversion of runoff around the proposed mine area; and consequent downstream effects of these modifications of the natural stream regime on quantity of water, chemical quality of water, and erosion and sedimentation. Amplification of these impacts follows.

(1) Removal of existing stream channels

A primary impact of surface mining in the North Extension area would be the removal of all natural stream channels within the area mined. Channels adversely affected include those of Spring Creek, Pearson Creek, and a number of comparatively small drainages that are tributary to these streams or that discharge directly to the Tongue River Reservoir (fig. 20). Lengths of channels removed and related information are as follows:

Stream channel	Length of valley to be removed (miles)	Average valley slope[1]	Average channel slope[2]
Spring Creek	1.4	0.010	0.0074
South Fork Spring Creek	.3	.009	.0080
Pearson Creek	2.0	.011	.0070
Other unnamed streams[3]	3.5	.018	.017

[1] Measured on valley floor along centerline of valley.

[2] Measured along meandering course of stream channel.

[3] Includes measurements of six small ephemeral stream valleys.

Alteration or removal of the above stream channels as a result of mining in the North Extension area would, in the absence of appropriate diversion channels, cause recurrent flooding and deposition of sediment in the active pits. This flooding in turn would cause frequent and unpredictable production delays and probably would necessitate the use of washing facilities to remove the sediment from the coal. In the event that all the sediment cannot feasibly be removed from the coal, some wastage of the coal resource or increase in ash content would occur.

The effect of the removal of existing stream channels on quantity and quality of surface runoff is discussed on pages 401-404.

(2) Interception and diversion of runoff

Removal of existing channels within the mine area requires the construction of earthen dams and diversion channels to intercept and carry surface runoff around the mine area (fig. 20). This diversion system, which would be accomplished in two phases (p. 68), would (1) alter the existing flow regimen in natural channels downstream, (2) change the physical character and appearance of the landscape, (3) destroy the existing plant cover on borrow and fill areas, and (4) locally modify the small animal habitat.

In contrast to diversion channels in the East Decker area, which were designed to function as permanent channels and, therefore, to carry peak discharges in excess of those expected from a 100-year flood, diversion channels in the North Extension area appear to be comparatively small and possibly would be subject to failure from excessive flows. The design capacity of these channels in relation to estimated peak discharges is summarized in the following table:

Stream diversion	Design capacity (ft^3/s)	Estimated peak discharge (see table 16)		
		25-year flood (ft^3/s)	50-year flood (ft^3/s)	100-year flood (ft^3/s)
Spring Creek	1,800	1,600	2,200	2,900
Pearson Creek[1]	700	700	1,100	1,500
Pearson Creek[2]	1,000	1,230	1,850	2,500

[1] Upstream from mouth of Pond Creek diversion channel.

[2] Includes flow from Pond Creek watershed.

Proposed initial diversion channels excavated in earthern materials in the North Extension area have been designed for flow velocities up to about 8 ft/s (table 40). These velocities would be moderately erosive in weathered clinker materials, which underlie the surface throughout most of the North Extension area, and highly erosive in alluvium underlying the bottom of Spring Creek valley (fig. 32)

Proposed concrete-lined reaches of the diversion channels are designed for flow velocities of as much as 43 ft/s. These high velocities would introduce problems from cavitation, and from energy dissipation at the transition from concrete to earthen channels. These problems would be difficult to resolve and would require extensive periodic maintenance of the system.

The engineering design for the second phase of the diversion system, which would replace the initial diversion channels as mining progresses westward, has not been completed pending observation and testing of the initial diversion system.

Secondary diversion ditches and small impoundments used to control runoff within the mine area would be temporary and should not significantly impact the environment. Any failure of these structures would result only in minor flooding of the active pit.

According to the proposed mining and reclamation plan, all diversion structures, channels, and settling ponds in the North Extension area would be removed and the areas restored at the conclusion of mining. Flows in Spring Creek, South Fork Spring Creek, and Pearson Creek would be routed over the final highwall and would follow depressions across the mined area and back into the original channel of Spring Creek (fig. 19). The erosional stability of these channels is discussed under Erosion and sedimentation, section III. B. 3. a. (5).

(3) Changes in quantity of water

It is estimated that surface runoff and consequent water yield to the Tongue River Reservoir from streams traversing the North Extension area would be reduced no more than about 6 percent or about 40 acre-feet annually during mining and no more than about 3 percent or about 20 acre-feet annually after mining and reclamation (table 46). This loss of water to the reservoir represents about one-hundredth of 1 percent of total annual inflow to the reservoir during the period of mining and less than one-hundredth of 1 percent of total inflow to the reservoir after mining. These estimates were obtained by the following reasoning.

The diversion impoundment on Pearson Creek and the impoundments constructed on Spring Creek and South Fork Spring Creek as part of the phase 2 or secondary diversion system (fig. 20) would probably function initially very much like the existing structure on Pond Creek (p. 201).

They would retain and dissipate a significant part of the runoff generated by small storms on their respective watersheds, but would retain only a comparatively small amount of the runoff generated by large storms. Seepage losses into the underlying alluvium and clinker would be appreciable and would move down valley through the clinker. Most, if not all, of this water would enter the active pits as ground-water flow and would be discharged to the Tongue River Reservoir. The impoundment basins would probably fill rapidly with sediment because of the appreciable size of the contributing watersheds, thereby progressively decreasing the volume of water stored. Evapotranspiration losses, therefore, should decrease correspondingly with time. These losses would never be eliminated, however, because of natural water-spreading that would occur on the alluvial deposits accumulated within and extending upstream from the impoundments. It is estimated that as much as 10 percent of the surface runoff might be dissipated by evapotranspiration during the period when the capacity of the diversion impoundments is greatest. Evapotranspiration losses should decrease to less than 5 precent of surface runoff after the impoundments have largely filled with sediment. Runoff, both during and after mining, from those parts of the Spring Creek and Pearson Creek watersheds that lie within the mine area should not be reduced appreciably. Current runoff from the proposed mine area, which is largely underlain by clinker, is minimal, probably averaging less than 0.2 inch annually (10 acre-feet/mi^2).

The foregoing estimates of surface-water losses in the North Extension area as a result of mining are probably on the high side. It should be stressed, however, that in the unlikely event that these losses were double the estimated amount, the long-term impact on the Tongue River Reservoir would be a reduction of inflow of less than one-hundredth of 1 percent.

The inferred loss of water to the Tongue River Reservoir as a result of mining would be partly, if not largely, offset by (1) a possible reduction of sediment yield to the reservoir (p. 416), (2) the added availability of water for livestock and wildlife afforded by storage of water in the diversion impoundments, and (3) increased forage production in those areas where natural water spreading on alluvial deposits extending upstream from the diversion structures would provide additional water for plant growth.

Two permanent surface-water supplies used as a source of water by livestock and wildlife would be interrupted near the end of the proposed mining operation. They are the Tongue River mine lake in sec. 33, T. 8 S., R. 40 E. (p. 205) and a spring in the bottom of South Fork Spring Creek valley (no. 2, table D-5, Appendix D). Removal of the lake would eliminate a local hazard posed by the abandoned steep-walled pit.

(4) Changes in chemical quality of water

Surface runoff diverted around the mine area to the Tongue River Reservoir should undergo little or no change in chemical quality. However, water that infiltrates the surface and augments ground-water recharge as a consequence of mining and reclamation can be expected to leach and transport higher concentrations of dissolved solids than a comparable flow that remains on the surface. The dissolved-solids content and rate of ground-water flow during and after mining in the North Extension area is discussed on p. 392-394. The impact of this water on the Tongue River Reservoir is described on p. 443.

The mine would use existing facilities at the West Decker mine for disposal of waste and wash waters. As no expansion of these facilities would be necessary to accommodate the additional discharge, no additional impact to the Tongue River Reservoir should occur.

(5) Erosion and sedimentation

(a) Stability of diversion dams

Properly designed diversion dams of the size and type proposed on Pearson Creek, Spring Creek, and South Fork Spring Creek channels should present no stability problems over the life of the proposed mine. These structures could fail, of course, if they are overtopped by excessive storm runoff that exceeds the design capacity of the diversion system or because of loss of capacity from sediment depostion. In that unlikely event, some flooding of the mine probably would occur, but because of the large area of the pits, any threat to the safety of men or equipment would be small. Because flooding as a result of structural failure in response to excessive runoff would be contained largely with the mine area, evironmental damage to the Tongue River Reservoir under these circumstances probably would be less than in the absence of mining.

The initial structure on Spring Creek would divert runoff directly from the Spring Creek channel into the diversion channel with little or no impoundment of water. Ephemeral flows, therefore, should enter the diversion channel essentially unimpeded without a significant change in either flow velocity or direction. Little erosion or sedimentation is expected, therefore, at the point of diversion or in the reach immediately upstream from the diversion.

Conversely, the diversion dam on Pearson Creek and the diversion dams constructed on Spring Creek and on South Fork Spring Creek as part of the secondary diversion system would impound runoff and, therefore, would function as both diversion and flood-control structures. Runoff from the contributing watersheds must pass through the reservoir basins before entering the diversion channels. Thus, these impoundments would function effectively as sediment-settling basins. The trap efficiency of these structures, although uncertain, would probably exceed 75 percent; that is, more than 75 percent of all fluvial sediment in transport would be deposited upstream from the diversions. With significant runoff and sediment deposition over time, the reservoir basins would progressively fill with sediment, thereby decreasing both the effect of the impoundments on flood control and the freeboard or elevation difference between the top of the dam and the bottom of the reservoir. Sediment deposition would not be confined to the reservoir basin, but would progress headward, upstream, as the impoundment fills with sediment and flows spread across the aggrading valley floor. The effect is much like that of an alluvial-fan deposit building upstream.

The proposed diversion structures should function adequately with minimal maintenance over the proposed life of the North Extension mine. On completion of the mining operation, the structures would be removed, thereby exposing the aggrading reservoir basin and the valley floor upstream to possible trenching.

(b) Stability of diversion channels

Neither the materials underlying the surface in the North Extension area or the topography present any serious challenge to the design and construction of essentially stable diversion channels that would carry surface runoff around the mine area. The proposed channels, however, generally would not be stable because they have been designed for abnormally high flow velocities and almost certainly would be subject to severe local erosion and consequent failure. Calculated maximum flow velocities for selected runoff events are listed in table 40. Calculations are based on design criteria furnished by the Decker Coal Co.

Table 40.--Calculated maximum flow velocities in diversion channels in the North Extension area

Diversion	Type of channel	Mean flow velocity for peak discharges having the indicated recurrence intervals[1] (ft/s)					
		2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
Spring Creek	Earthen	4.5	6.0	6.9	7.8	----	----
	Concrete	23	31	36	41	----	----
Pearson Creek[2]	Earthen	3.3	4.8	5.6	6.3	----	----
Pearson Creek[3]	Earthen	4.0	5.6	6.4	----	----	----
	Concrete	26	37	43	----	----	----

[1] Estimated peak discharges are given in table 16. Dashes indicate peak discharges higher than the design capacity of the channels.

[2] Upstream from mouth of Pond Creek diversion channel.

[3] Includes flow from Pond Creek diversion.

According to the U.S. Department of Agriculture (1972a), allowable velocities for flows in earthen channels depend primarily on the grain size and cohesiveness of the channel materials and on the sediment concentration of the flow. Generally, the larger and more cohesive the channel materials and the higher the sediment concentration, the higher would be the allowable velocity. For example, those parts of the diversion channels that are excavated in undisturbed clinker materials would probably have an allowable velocity of as much as 10 ft/s, provided that no appreciable sedimentation occurred in the channel upstream from the diversion. Any reduction in sediment load would tend to increase the erosiveness of the flow in the channel downstream and require a corresponding reduction in velocity. In contrast, the allowable velocity in those parts of the diversion channels that are excavated in comparatively noncohesive alluvial materials would be probably no more than 3 to 4 ft/s. The low allowable velocity in these alluvial materials is attributed to their typically fine-grained character and to the probable deposition of most of the sediment load in the impoundments upstream from the diversions.

It follows from the foregoing discussion and table 40 that those parts of the diversion channels excavated in clinker materials probably would be stable over the life of the mine and probably would require minimal maintenance. Conversely, those parts of the diversion channels that are excavated in alluvial materials probably would be subject to erosion by all peak discharges having a recurrence interval of more than about 2 years. Local downcutting of the type shown in figure 50 would be expected, yielding large quantities of sediment to settling ponds downstream and necessitating periodic maintenance of this part of the system. The high-velocity concrete channels also would be subject to extreme erosive forces and probable failure during high peak discharges.

Problems associated with high velocities such as cavitation, negative pressures, energy dissipation, and the transition from concrete to earthen channels would be difficult to resolve and probably would require periodic maintenance.

(c) Sedimentation in settling basins

According to the proposed mining plan, sediment-settling ponds would be constructed near the outlets of the Spring Creek and Pearson Creek diversion channels to reduce sediment yield to the Tongue River Reservoir (fig. 20). The settling pond on Spring Creek (p. 70) would have an initial capacity of 140 acre-feet; the settling pond on Pearson Creek (p. 72) would have an initial capacity of about 50 acre-feet.

Assuming that very little sediment from the Spring Creek watershed would be deposited upstream from the initial stage diversion, sediment yield to the Spring Creek settling pond during this stage (6 to 9 years) probably would average 10 to 15 acre-feet annually (table 18), provided that large quantities of sediment are not eroded from the diversion channel. Assuming a trap efficiency of at least 50 percent, the settling pond should have an effective life of at least 9 years. To maintain the effectiveness of this structure thereafter, it probably would be necessary to remove the sediment from the pond at least once during the period of mining. No provisions have been made for the disposal of these excavated materials.

Most of the sediment yielded by the Pearson Creek watershed and the Pond Creek diversion probably would be deposited upstream from the respective diversion impoundments. The design capacity of the Pearson Creek diversion settling pond, therefore, should be more than adequate to store sediment over the proposed life of the diversion (15 to 18 years), provided that large quantities of sediment are not eroded from the diversion channel.

(d) Erosion of soil materials and spoil embankments

Disturbance of ground cover, local removal and stockpiling of soil materials, and the formation of steep spoil embankments prior to reclamation should significantly increase erosion by both wind and water within the mine area.

The products of erosion by water would be retained largely within impoundments in the mine area or would enter the active pit and would be trapped in settling ponds before discharging the mine effluent to the Tongue River Reservoir. Erosion of the box cut spoils along the east margin of the mine might contribute some additional sediment to the Tongue River Reservoir.

Erosion by wind of disturbed areas where the soil has been removed prior to mining, of soil and coal stockpiles, and of unreclaimed spoil piles may produce moderate to large amounts of dust. Because of the prevailing westerly winds, most of the products of this erosion would be deposited in the eastern part of the mine area and to a lesser extent in the Tongue River Reservoir. The impact should be primarily to air quality and to loss of soil materials for subsequent reclamation rather than to any significant degradation of the environment in the areas of dust accumulation. The impact to the Tongue River Reservoir from wind-blown sediment should be no greater than that of the existing West Decker mine.

(e) Erosion along roadways

Appreciable erosion by wind and water is expected along roadways constructed or relocated in conjunction with mining activities. The products of wind erosion, like those from other disturbed areas, would be deposited largely downwind in the eastern part of the mine area and to a lesser extent in the Tongue River Reservoir. The impact would be largely to air quality as these wind-blown sediments should not accumulate to a depth of more than a few inches locally and possibly may enhance the growth of the plant cover by increasing the infiltration capacity of the existing soils.

The products of erosion by water of virtually all roads within the mine area would be retained within impoundments and settling ponds in the mine area and would not reach the Tongue River Reservoir. The notable exception would be the relocated highway, Route FAS 314, along the west side of the Tongue River Reservoir (fig. 20). Although the surface of this roadway would be protected by an asphalt coating, the east embankment of the roadway would be subject to wave erosion during periods of high water levels in the Tongue River Reservoir. In the absence of adequate protection, wave action could erode large volumes of sediment from this roadway. Virtually all of this sediment would be deposited within the reservoir basin.

(f) Stability of postmining channels

The proposed plan (p. 73) states that the impoundments on Spring, South Fork Spring, and Pearson Creeks would be removed after the completion of mining and that runoff from these watersheds would follow depressions across the reclaimed mined area (fig. 19). The plan, however, does not describe the physical characteristics of these proposed channels or their long-term stability. It is necessary, therefore, to speculate on the probable character and stability of the natural channels that ultimately would develop to carry runoff and sediment from the Spring Creek, South Fork Spring Creek, and Pearson Creek watersheds to the Tongue River Reservoir.

After removal of the Spring Creek, South Fork Spring Creek, and Pearson Creek diversion impoundments, flows would enter the mined area over the highwall unimpeded and would follow the depression left by the final cut. Runoff from Spring Creek and South Fork Spring Creek watersheds would drain generally southeastward to merge with runoff from the Pearson Creek watershed (fig. 19). The combined flow then would drain generally eastward across the reclaimed surface.

Data from figure 19 show that the remaining highwall at Spring Creek would have a drop of about 25 feet and an average slope of about 14 percent or 0.14. The channel downstream to the junction with South Fork Spring Creek would have an average slope in the absence of any meandering of about 0.014 (73 feet per mile), which is somewhat more than the present slope of Spring Creek valley (0.010) and about twice the slope of the present channel (0.0074). The highwall at South Fork Spring Creek would have a drop of about 35 feet and an average slope of about 12 percent or 0.12. The channel downstream to the junction with Pearson Creek would have an average slope in the absence of any meandering of about 0.003 (16 feet per mile), which is considerably less than the present slope of South Fork Spring Creek valley (0.009) and less than half the slope of the present channel (0.0080). The highwall at Pearson Creek would have a drop of about 45 feet and an average slope of about

18 percent or 0.18. The channel downstream to the junction with Spring and South Fork Spring Creeks would have an average slope in the absence of any meandering of about 0.003 (16 feet per mile), which is considerably less than the present slope of Spring Creek and Pearson Creek valleys across the mine area and less than half of the present slope of the channels in those valleys.

Each of these newly formed channels would be characterized by (1) an aggrading reach extending upstream from the restored site of the diversion dam, (2) an oversteepened reach across the highwall, and (3) a flattened reach extending along the bottom of the depression left by the final cut and across the mined area. None of these channel reaches would be in geomorphic equilibrium. In the absence of specific mitigating measures that would control local erosion or induce aggradation, these channels would undergo a generally predictable sequence of changes through natural fluvial processes. Runoff from the respective watersheds entering the aggrading reach upstream from the restored site of the diversion dams would continue to spread naturally across the aggrading, vegetated valley bottoms. The flow velocity would decrease accordingly, and all but the fine-grained sediments in transport would be deposited. In the absence of the diversion dam, outflow from these aggrading reaches then would plunge over the highwall and accelerate to extremely erosive velocities, especially for flows carrying a small sediment load. A vertical over-fall or headcut would form at the highwall and migrate rapidly headward, upvalley, cutting a channel through the full thickness of the alluvium underlying the valley floor. Downcutting of the underlying clinker would also occur, but at a much slower rate. The products of this accelerated valley trenching would be carried over the highwall into the flattened reach downstream where flows would spread across the width of the reclaimed depression left by the final cut. Deposition of the coarser-grained sediments would follow, the amount depending on the decrease in velocity that would occur in response to the change in slope and depth of flow. Appreciable aggradation of fine-grained sediments would be expected in the comparatively flat reaches extending downstream from the highwall in the South Fork Spring Creek and Pearson Creek drainages and across the reclaimed mine area. Comparatively little aggradation, and possibly erosion would occur in the steeper reach extending immediately downstream from the highwall in the Spring Creek drainage. Meandering would follow, possibly causing some lateral erosion of the reclaimed slopes along the final cut. This meandering, however, would further reduce the channel slope and flow velocity; thereby augmenting the aggradational process.

The channel reach extending downstream from the confluence of the Spring Creek and Pearson Creek drainages across the reclaimed mine area should readily adjust to the combined flows of these watersheds with no significant adverse impacts because of the low valley slope and appreciable valley width. The increased discharge and the reduced sediment load, however, would very probably erode the old channel of Spring Creek in the area east of the mine. This erosion could form a headcut that would tend to migrate upvalley through the reclaimed area.

The tendency over the long term would be to lower the channel profile upstream from the highwall through erosion and to raise the channel profile downstream from the highwall through aggradation until eventually geomorphic equilibrium is reestablished. A different sequence of changes would occur with appropriate mitigating measures (p. 556-561).

The primary impact to postmining channels in the absence of protective measures would be the erosion of a deep narrow trench or gully upstream from the highwall on Spring Creek, South Fork Spring Creek and Pearson Creek valleys and possibly on other smaller stream valleys terminated by the highwall. These gullies might eventually extend headward appreciable distances and would be the source of large volumes of sediment, a significant part of which might reach the Tongue River Reservoir. The valley trenching, in turn, would cause significant reduction in plant cover on the dissected valley floors. Aggradation in the reach downstream from the highwall should not significantly impact the environment. The accumulating materials should be no less suitable for plant growth than most soils in the area and should rapidly develop a natural riparian plant cover similar to that on other flood-plain deposits in the area. This cover should not be adversely affected by continuing aggradation.

(g) Stability of the reclaimed mine area

Runoff from the reclaimed mine area may be more or less than from the premining terrain, depending on the outcome of the reclamation process. Assuming, however, uniform distribution of a layer of topsoil more than a foot thick, establishment of an acceptable plant cover, and a topography with a poorly developed drainage system, annual runoff from the reclaimed area would probably be reduced as much as 50 percent.

If so, erosion and sediment yield should be decreased accordingly. Should establishment of the plant cover be locally unsuccessful, however, or should the plant cover deteriorate in the future for any reason, increased runoff and erosion would be expected, and sediment yields to the Tongue River Reservoir from the mined area might increase to several times the premining rate.

(h) Sediment yield to the Tongue River Reservoir

Because of the many uncertainties associated with the final design, construction, performance, and maintenance of the proposed diversion system in the North Extension area, the outcome of the reclamation plan, and the unpredictability of runoff events during the life of the proposed operation, any appraisal of the effect of the proposed mining plan on the sediment yield to the Tongue River Reservoir is necessarily more qualitative than quantitative in nature. Moreover, total sediment yield to the reservoir could vary by several orders of magnitude, depending on (1) the frequency and intensity of runoff, events, (2) the use of various mitigating measures, and (3) adequate maintenance of water-control structures and channels. The following estimates are based on the specific proposals of the Decker Coal Co. for the initial diversion system, and on the assumption that only the maintenance necessary for efficient operation of the mine would be completed. The reader is referred to pages 559-561 for a discussion of sediment yield to the Tongue River Reservoir in the event that more extensive mitigating measures are adopted.

On that basis, it is estimated that the sediment yield to the reservoir might be reduced as much as 60 percent or about 11 acre-feet annually during the first 6 to 10 years of mining, depending on (1) the amount of erosion occurring from high flow velocities in the diversion channels, (2) the trap efficiency of the settling ponds near the outlets of these channels, and (3) possible increased erosion in the channels downstream from the settling ponds because of the reduced sediment concentrations in the runoff. Sediment yield from the Spring Creek and Pearson Creek watersheds might be decreased to less than 5 acre-feet annually after the diversion impoundments are constructed on Spring Creek and South Fork Spring Creek channels as part of the secondary diversion system. Sediment yield to the reservoir could increase progressively with time, however, because of increased erosion in the diversion channels and in the natural channels downstream and because of decreasing trap efficiency of the settling ponds as they progressively fill with sediment. The result might be that the sediment yield to the Tongue River Reservoir would not be significantly increased or decreased during the period of mining, although it appears more probable that the sediment yield to the reservoir during this period would be less than normal.

Very little additional sediment should enter the reservoir from the mine area during the period of mining. In the absence of protective measures, however, significant quantities of sediment probably would be carried into the reservoir as a result of wave erosion along the east embankment of Route FAS 314.

After the proposed mining operations and reclamation measures are completed, the rate of sediment yield to the reservoir probably would increase dramatically during the period of channel readjustment in Spring Creek, South Fork Spring Creek, and Pearson Creek valleys. Eventually, however, these channels should stabilize over a period of several decades, or possibly several centuries, and the sediment yield to the Tongue River Reservoir should return to approximately the premining rate. Total long-term sediment yield to the reservoir as a result of mining could be several thousand acre-feet more than would be expected in the absence of mining. Virtually all of this added sediment would probably be obtained from channel erosion upstream from the highwall. Little or no increased erosion is expected on reclaimed spoil materials within the mined area. Erosion on the relocated highway would continue in the absence of protective measures, but at a progressively decreasing rate.

Changes in the rate of sediment yield to the Tongue River Reservoir would be accompanied by some changes in areas of sediment accumulation. During the life of the mining operation, deposition would continue within the reservoir basin at the mouth of Spring Creek. Deposition would no longer occur at the mouth of Pearson Creek, however, because of the permanent diversion of this stream. Deposition would occur instead at the outlet of the Pearson Creek diversion channel (fig. 20). On completion of mining, runoff from the Pearson Creek watershed would be made tributary to Spring Creek. Thereafter, all sediment from the Spring Creek and Pearson Creek watersheds would enter the reservoir at the mouth of the old Spring Creek channel.

c. An enlarged Tongue River Reservoir

Impacts to the North Extension area from completion of an enlarged Tongue River Reservoir would be similar to those described for the East Decker area. The reader is referred to page 355 for a discussion of the relative time frames for construction of an enlarged reservoir and completion of coal mining in the Decker area.

(1) Impacts of an enlarged reservoir on the mine

Completion of a stage I dam (p. 81) raising the reservoir spillway to an elevation of 3,438 feet and subsequent impoundment of water to that level would back water into the North Extension area in the absence of protective dikes and would flood an additional 110 acres that are not flooded by the existing reservoir (fig. 21). Only about 2 acres of the actual area to be mined would be submerged should the enlarged reservoir be in existence and filled to spillway level at the onset of mining. None of the mine area would be flooded after the first turnover cut because the spoils would provide a protective dike across the full width of Spring Creek Valley. For all practical purposes, therefore, no economic conflict exists between the development of coal in the North Extension area and the construction of a stage I reservoir. Moreover, no part of the existing West Decker access routes, railroad, or plant facilities, all of which would be used to facilitate mining in the North Extension area, would be endangered by a stage I reservoir. A stage I reservoir, however, would submerge at spillway level (3,438 feet) almost 2 miles of that part of relocated Route FAS 314 that closely parallels the shoreline of the existing reservoir. About 800 feet of roadway would be flooded in Pearson Creek valley and about 9,400 feet of roadway would be flooded in Spring Creek valley. These and adjacent sections of the relocated roadway would also be subject to severe wave erosion, unless protected by riprap.

The primary impact of enlarging the reservoir to stage I would be to greatly increase ground-water seepage from the reservoir into the active pit. Depending on the hydraulic connection between the enlarged reservoir and the permeable clinker that underlies much of the North Extension area, inflow to the mine from the reservoir could be increased to more than 20 ft^3/s. Added leaching of the spoil materials would occur, but very probably the adverse effect on the quality of water in the reservoir would be more than offset by the dilution afforded by the greater volume of impounded water.

Completion of a stage II dam raising the reservoir spillway to an elevation of 3,453 feet and impoundment of water to that level prior to completion of all surface-mining activities in the impacted area is not currently regarded as a viable proposal. Should that action be taken, however, the reservoir in the absence of protective dikes would flood an additional 340 acres in the North Extension area that are not flooded by the existing reservoir (fig. 21). A stage II reservoir could flood the mine only in the early stages of development; thereafter, the spoils from the box cut and from the first turnover cut would provide a protective barrier. No part of the West Decker mine facilities would be flooded. The new shoreline, however, would impinge directly on spoil embankments with consequent locally extreme bank erosion. Ground-water inflow to the mine probably would be increased to beyond the practical limits of dewatering the active pits.

(2) Impacts of the mined area on an enlarged reservoir

If mining is completed prior to construction of the High Tongue Dam --stage I, the enlarged reservoir would have no impact on mining operations but the reclaimed area would adversely affect the reservoir and vice versa. Very little erosion of reclaimed spoils materials by wave action is expected because very little spoils would be placed below an elevation of 3,438 feet. Saturation and leaching of spoils in the mine area by ground-water would occur as described in the East Decker area (p. 359). Very probably, however, somewhat larger volumes of water would move from the enlarged reservoir, through the clinker into the dragline-laid spoil materials in the North Extension area during high water levels or high stage and out of the spoils and back into the reservoir during low stage because of the expected greater permeability of these materials over those in the East Decker area. Similarly, leaching of the spoils should increase the dissolved solids reaching the reservoir, but because of the dilution afforded by the greater volume of water in the enlarged reservoir, the effect on the quality of water should be less deleterious than in the existing reservoir after mining. Impacts of a stage I reservoir on relocated Route FAS 314 are described on page 418.

Completion of a stage II reservoir and impoundment of water to a spillway elevation of 3,453 feet would submerge most of that part of relocated Route FAS 314 that parallels the shoreline of the existing reservoir. Locally severe erosion of reclaimed spoil materials by wave action would pose a major environmental impact that would require protective measures. Increased leaching of spoil materials would be expected; however, the larger volume of water generally impounded in a stage II reservoir would provide a significant dilution effect. Thus, the quality of water released from the reservoir for use downstream would probably not be measurably different from that discharged from the present reservoir or from a stage I reservoir.

4. Air quality

The mining of an estimated 2.3 million tons of coal per year from the proposed North Extension mine would create impacts on air quality for the period of active mining. The major potential atmospheric pollutant emissions ascribed to the North Extension mining operation are as follows (VTN Colorado, 1975b):

(1) Fugitive dust emissions from blasting, removal and disposal of overburden, wind erosion on unvegetated spoil piles, extraction of coal, and traffic on haul roads.

(2) Coal dust from additional coal-processing operations such as conveyor transport, size reduction, and loading operations at the existing coal-processing facilities at the West Decker mine.

(3) Particulates and gaseous emissions from machinery and trucks operating at the mine and from the unit-train transport of coal over the spur line.

(4) Indirect-source emissions from an increase in the number of motor vehicles traveling to and from the mine site.

Atmospheric pollutants commonly associated with these emission sources are identified in the section describing air-quality impacts of the proposed East Decker mine (p. 361).

The estimated uncontrolled emissions from the North Extension mine for an average mining year are summarized in tables 41, 42 and 43. Emission factors for fugitive dust were determined from formulas developed by the Midwest Research Institute (1974) as well as those published by the U.S. Environmental Protection Agency (1973). These values are order-of-magnitude estimates with no applied control measures. Field observations at similar mining operations indicate that the uncontrolled emission levels predicted may be on the high end of the possible emission-level range. The methods used for determination of uncontrolled emission values are given in Appendix C.

The indirect-source emissions associated with increased motor vehicle travel to and from the North Extension mine operation should be minimal. Maintenance and production workers required for operation of this mining facility would, in all probability, not exceed a maximum of 75 additional employees (table 47). The motor-vehicle volumes to be generated by this number of employees is well below the criteria defined by EPA for indirect-source planning.

The reader is referred to page 364 for a discussion of the potential impacts of dust, slack-coal fires, and methane gas as potential mining-related atmospheric pollutants.

Air-quality impacts caused by the proposed relocation of Route FAS 314 are discussed on pages 434-436.

Table 41.--Estimated uncontrolled particulate emissions for the surface mining of coal at the North Extension mine (modified after VTN Colorado, 1975b)

Mining activity	Estimated fugitive dust or particulates (tons/year)
Topsoil removal	3
Overburden removal	200
Coal extraction	57
Wind erosion of spoil piles	43
Overburden recontouring	75
Topsoil replacement	3
Haulage traffic	340
Coal crushing	120
Coal handling and conveying	690

Table 42.--Estimated diesel-exhaust emissions from mine vehicles and equipment at the North Extension mine (modified after VTN Colorado, 1975b)

Pollutant	Diesel truck emissions (ton/year)	Total equipment emissions (tons/year)
Particulates	0.1	0.2
Carbon monoxide	1.4	2.7
Hydrocarbons	.2	.5
Nitrogen oxides	2.3	4.6
Sulfur oxides	.2	.3

Table 43.--Estimated train emissions resulting from coal transport at the North Extension mine (modified after (VTN Colorado, 1975b)

Pollutant	Estimated emissions (tons/year)
Particulates	3.2
Carbon monoxide	17
Hydrocarbons	12
Nitrogen dioxide	48
Sulfur dioxide	7.4

5. Vegetation

a. Existing vegetation destroyed

The most dramatic and critical impact on existing vegetation in the North Extension area would be its destruction by mining. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated. These include: The mined area, areas of highwall, haulroads, and the area disturbed by relocation of Route FAS 314. In the "associated disturbance" areas, the effects on vegetation would range from total destruction in some areas to relatively minor disturbances in others.

Related impacts include the loss of competitive advantage of some deep-rooting plants for a period after mining, and the loss of vegetation diversity for a period after mining. Both of these impacts are discussed under vegetation impacts for the East Decker proposal (p.365-366).

b. Impacts on grazing and agriculture

Approximately 437 acres of irrigated cropland would be taken out of production when the North Extension area is fenced. Crops include small grains and alfalfa hay grown in a rotation system and used for supplemental livestock feed. In addition, fencing of the proposed mine project area would exclude about 1,890 acres of grazing land, representing approximately 500 AUM's, from use by livestock during the life of the project. Undisturbed vegetation within the proposed mine boundary, much of which is overgrazed, would benefit, however, from the exclusion of domestic grazing for the 20-year life of the project.

c. Effects of dust on vegetation

Soil and coal dust (air-borne particulates) may influence the pre-mining or reclaimed vegetation in the North Extension area. A discussion of dust impacts on reclaimed and native vegetation is presented under the discussion of vegetation impacts for the East Decker mine (p. 367-368).

6. Wildlife

a. Mammals and birds

(1) Mule deer

Access roads, mining and topsoil storage areas would remove potential feeding, fawning, resting, and wintering habitat. Increased travel in the mine area would increase the chances of poaching and deer-vehicle collision losses.

Mule deer are frequently seen within the boundaries of the West Decker mine, and it is probable that this could also happen at the North Extension site. Possible reasons for such sightings are ease of observability, the presence of new, ungrazed grasses and forbs on revegetated mine areas, acclimation of the animals to mine disturbances, and the protection afforded by the prohibition of hunting within the mine areas.

(2) White-tailed deer

Of the three big-game species present in the Decker area (mule deer, white-tailed deer, and antelope), the white-tailed deer is expected to be the species least impacted by mining operations. White-tailed deer are adaptable to human presence, and the lack of North Extension mining activity in riparian areas would result in minimal impacts to this species. Fences would be constructed so as to not hamper deer movement. The only significant impact expected would be the increased chance of poaching and deer-vehicle collisions.

(3) Antelope

Antelope would be the most severely impacted big-game species in the North Extension area because mining and associated activity would create a reduction in year-round habitat. Antelope using the area within the proposed North Extension mine would be displaced, as would the group of antelope utilizing the area immmediately north of the proposed mine. Reductions in Decker area antelope populations would occur. In addition, increased travel in the North Extension area would increase the chances of population losses through poaching and antelope-vehicle collisions.

(4) Sage grouse

Of all game animals in the study area, the sage grouse probably would be the most severely impacted by mining. Removal of overburden would destroy a large amount of their food source, and on a short-term basis, some reduction in local sage grouse populations may occur owing to some loss of nesting areas. Sage grouse are intolerant of increased human activity, especially in nesting and wintering areas (VTN Colorado, 1975b). Moreover, removal of plant cover in the North Extension area would remove a large amount of the plant cover utilized by sage grouse.

(5) Sharp-tailed grouse

Fencing of the North Extension project area would take 437 acres of irrigated cropland out of production thereby removing alfalfa as a food and cover source for sharp-tailed grouse. To date, however, few sharp-tails have been observed within the proposed mine area.

(6) Hungarian partridge

Hungarian partridge would suffer little impact because the Decker area provides poor habitat for "Huns" and because most of these birds observed in the vicinity have been located outside of the proposed mine boundary.

(7) Chukar partridge

Impact on chukar partridge would be minimal as none of these birds has recently been observed in the vicinity of the proposed North Extension mine.

(8) Ring-necked pheasant

Pheasants would be lightly impacted by mining activity at the North Extension site as some of their habitat in Spring Creek valley would eventually be removed by mining. Pheasants, a large, often colorful bird, would be subject, however, to an increased poaching potential as a result of increased human activity in the general area.

(9) Great blue heron and double-crested cormorant

No physical impact on the heron and cormorant rookeries in sec. 14, T. 9 S., R. 40 E. (fig. 56) is anticipated as a result of mining at the North Extension site (fig. 3). In other areas, herons and cormorants have proved tolerant to levels of activity similar to that proposed for the North Extension area. Little effect on birds currently utilizing the rookery has resulted from activity at the West Decker mine.

(10) Geese, ducks, and shore birds

Fencing of the North Extension project area and subsequent termination of agricultural activities within the area would remove seasonal stubble fields in secs. 33 and 34 T. 8 S., R. 40 E. These stubble fields are a principal feeding area for geese in the vicinity of the Tongue River Reservoir.

Geese nesting adjacent to the reservoir in secs. 33 and 34 most likely would not be disrupted by North Extension mining activities. It is expected that migrants and other nonnesting geese using the reservoir would tolerate both construction and mining activity.

As with geese, ducks and shore birds nesting along the western shore of the reservoir would probably not be adversely impacted by the North Extension mining activities. Increased waterfowl and shore bird populations since the beginning of the West Decker mine suggest that such species adapt to increased noise levels.

Hunting pressure on waterfowl utilizing the Tongue River Reservoir may decline inasmuch as mine-safety requirements permit no hunting within the mine areas.

(11) Osprey

Known osprey nesting in the Decker area is currently limited to one nest located on the east side of the Tongue River Reservoir about 200 feet west of the proposed railroad alignment for the proposed East Decker mine (fig. 56). These birds obviously have become accustomed to disturbances caused by the existing mine and county road. The fact that they rebuilt their nest four times in 1975 after it was blown from the tree indicates the extent of their determination to nest in the area (Montana Department of Natural Resources, 1976).

(12) Bald eagle

To date increased activity at the West Decker mine has not caused discernable impacts on bald eagles wintering in the area. As in other wintering areas, the eagles have become habituated to this man-caused disturbance (Montana Department of Natural Resources, 1976). Furthermore, there are no available data to suggest that the proposed North Extension mining operation would alter bald eagle use of the area. Construction of powerlines may increase accidental death through electrocutions and collisions. Mining would cause some loss of available feeding areas.

(13) Golden eagle

The golden eagle is not expected to be seriously impacted by the proposed coal mining at the North Extension site. Accidental deaths might increase from construction of powerlines, and mining would remove small portions of available hunting areas. No nests are known to exist around the area, so no impact on nesting sites would occur.

(14) Turkey vulture

No significant impact to turkey vultures using the North Extension and adjacent areas is anticipated.

(15) Nongame birds and mammals

Impacts on nongame birds and mammals in the North Extension area would be the same as those described for the East Decker mine proposal (section III. A. 6. a. (15)).

b. Fish

The fisheries of the Tongue River Reservoir could be negatively impacted if mining at the proposed North Extension site causes substantial changes in reservoir water quality and sediment concentrations. Sodium is an element of particular concern because it is toxic to fish at high concentrations and also may be toxic at lower concentrations when mixed with other elements (Montana Department of Natural Resources, 1976a).

Increased sodium or other chemical levels in the reservoir could result, although it is not expected, from the leaching of North Extension mine spoils or from mine-water discharge into the reservoir (see discussion on water resources, p. 443-447). Increased sodium levels measured during the summer of 1975 as a result of reservoir drawdown were found to have no observed fishery impact.

If a substantial increase in reservoir sedimentation were to occur as a result of mining in the North Extension area, fish productivity might decline as a result of the burial and smothering of "incubating" fish eggs. Food sources (i.e., benthic invertebrates, etc.) could also be covered in those areas where reservoir sedimentation occurs.

The North Extension mine, as proposed, would interrupt only Spring and Pearson Creeks, both of which are ephemeral. No fisheries, therefore, exist within the mine boundaries.

Increased recreational demand resulting from Decker area mine development (i.e., fishing, hunting, boating, etc.) is expected to have little impact on the fishery resource of the Tongue River Reservoir.

7. Archaeological and historical sites

Archaeological sites identified in the proposed North Extension project area would be largely eliminated by mining and associated activities. Fredlund (1976) identified eight sites within the project area, (figure 63A) and Lahren (Written communication, December 3, 1976) identified an additional four sites. None of these sites is currently listed in the National Register of Historic Places and to date none has been recommended for nomination to the National Register (Ken Korte, State Historic Preservation Officer, written communication, February 4, 1977).

Given the number of sites discovered by both Fredlund and Lahren it is highly probable that additional sites not located in either survey would also be destroyed by mining in the North Extension area. Thus a possibility remains that a significant archaeological site may be destroyed due to the fact that it has never been discovered.

Professional differences of opinion as to what should constitute an archaeological site appear to be partly responsible for the additional site locations that Lahren identified following completion of Fredlund's study.[1/] Furthermore, total recovery of all sites on large tracts of land is very difficult and probably would not be necessary to adequately inventory and appraise the archaeological resources of the North Extension area. Fredlund's discovery of sites in the North Extension area may have been seriously hindered by the exceptionally dense plant cover during the period when the survey was conducted. Abnormal plant growth occurred in response to above normal precipitation in the area during the previous year.

All eight sites identified by Fredlund in the North Extension area were sketch-mapped, collected, and photographed. With the exception of site 24BH1525 (Channel rock piles), power augering was used as a subsurface evaluation technique in areas having subsurface archaeological site potential. Augering failed to reveal any presence of buried artifacts. A subsurface examination of site 24BH1525 remains to be completed before the presence or absence of deeply buried artifacts can be confirmed. Because site 24BH1525 is on federally owned lands administered by the Bureau of Land Management, a subsurface exploration permit is required prior to such testing.

[1/] Archaeological site definitions and survey standards related to Fredlund's and Lahren's work in the Decker area are discussed on pages 613-614 and in Appendices H and I.

With the exception of site 24BH1525, Fredlund recommended that no further appraisal was necessary. The disturbance of such sites by mining should have minimal impacts on man's understanding of the Decker area cultural resources inasmuch as each site has been properly recorded and evaluated. All important artifacts have been salvaged and preserved.

An unknown probability for significant loss of subsurface material still exists at site 24BH1525. Accordingly, the disturbance of this site by mining prior to subsurface testing could result in the permanent loss of archaeological resources.

Except for the collection of two bifaced fragments, the four sites identified by Lahren in the North Extension area have only been observed (table 33B). Should mining disturb these sites prior to appropriate study and recovery of artifacts, significant archaeological resources could be lost.

No structures or ruins within the North Extension project area are listed in the National Register of Historic Places, nor has any structures or ruin within the project area been so nominated. The only old structure within the project area are those associated with the Tongue River mine, and these are neither of historic nor architectural significance (Murray 1973).

8. Recreational facilities and activities in the Decker area

Decker Coal Co.'s proposed North Extension mine would exclude all lands within its boundaries from recreational use. Adjacent lands may be subject to slightly greater utilization pressures owing to this decline in available land area.

Increased use of the existing recreation facilities adjacent to the Tongue River Reservoir would occur because of the influx into the Decker area of people directly involved with mining activities. These facilities are currently in poor condition and of somewhat limited capacity. The proposed North Extension mine may result in use beyond their present tolerance, resulting in land disturbances, destruction of private property, and possible pollution and littering problems in areas of increased use. Human interaction problems may also arise from the increased congestion of recreation facilities.

Hunting pressure in the Decker area and the resultant impacts on wildlife populations should not substantially change when compared to present conditions. Increased human activity in the vicinity, however, would cause an increase in poaching and accidental vehicle-caused deaths for some species, especially deer and antelope.

Additional impacts on recreation in the Decker area would be caused by proposed relocation of Route FAS 314 (p. 434-437).

9. Aesthetics

Loss of vegetation and wildlife, coupled with landform degradation, location of spoil banks, loading equipment, the railroad spur, buildings, and coal-processing equipment, would detract from the aesthetic attributes of the area. This may be especially true for those people that use the Tongue River Reservoir for recreation purposes (see section III. B. 8. above). Potentially, the loss of air quality and any increases in ambient noise levels could severely degrade the sense of peace and tranquility now present in the North Extension area. General increases in human activity and demands brought about by this increased population could potentially impact the aesthetic environment well beyond the proposed mine boundaries. However, it is not possible to determine the severity of this impact at present. (VTN Colordao, 1975b).

The North Extension mine would also have aesthetic impacts on recreationists using the Tongue River Reservoir and Tongue River Recreation Area. The recreation area (SE¼ sec. 26, T. 8 S., R. 40 E) is located approximately three-quarters of a mile northeast of the North Extension project area and, as such, would have a far greater aesthetic impact than would the East Decker Mine (fig. 63A). North Extension spoil piles and load-out facilities would be visible from many parts of the reservoir and adjacent shoreline. Similarly, dust clouds, especially those associated with blasting, would be frequently visible in the Decker area. In addition to visible aesthetic impacts, such audible activities as blasting and coal crushing could negatively impact the recreational pleasure of reservoir and recreation area users.

10. Highway relocation

The major impact of relocating Route FAS 314 (p. 75) would be the loss of approximately 94 acres of range and agricultural land. The principal vegetation types include mid-short-grass prairie, sagebrush steppe, agricultural and riparian plant communities (see section II. B. 1, fig. 20, and fig. 51). Decker Coal Co.'s proposed relocation would cause decreases in available grazing forage, irrigated cropland, and wildlife habitat (see section III. B. 6.).

Highway maintenance costs to Big Horn County would increase owing to the additional mileage resulting from Decker Coal Co.'s proposed relocation.

Initial maintenance costs would be minimal, but could be expected to reach $1,000 to $1,500 per mile per year toward the end of the road's design life.

A slight decrease in local air quality would occur as a result of heavy-equipment vehicular emissions during any construction activities. The secondary-highway relocation would not be in conflict, however, with the State Implementation Plan to achieve Federal ambient air-quality standards.

As is the case for the proposed East Decker mine, the long-term impact of traffic using the relocated section would be minor as indicated by the requirement for EPA review of highway projects. According to these requirements, highway projects are reviewed by EPA when the ten year projected traffic is 20,000 vehicles per day. This is approximately 80 times more than the 1995 projections of 250 vehicles per day on the proposed relocation of Route FAS 314.

The drainages of Spring and Pearson Creeks, both of which are ephemeral, would be crossed by the relocation as proposed. The exact location of such crossings would depend on Decker Coal Co.'s final design of the recontoured mined surface and the approved alignment of relocated Route FAS 314. Such crossings raise the remote possibility of future highway floodings in these areas as well as the potential for erosion and sedimentation resulting from construction activities.

Decker Coal Co.'s proposed alignment is above the spillway level of the existing Tongue River Reservoir. Were the proposed High Tongue Dam to be built, however, approximately 2 miles of the company's proposed alignment would lie below the stage I spillway elevation (p. 418-419). Such expansion of the reservoir capacity is considered a major undertaking, however, as extensive right-of-way acquisition would be necessary.

Relocation of people, buildings, or businesses would not be anticipated if Decker Coal Co.'s proposed route were approved, nor would it take land from a publicly owned park, recreation area, or wildlife/ waterfowl refuge of local, state, or national significance. The proposed alignment would come within about three-quarters of a mile of the Tongue River Recreation Area (SE¼ sec. 26, T. 8 S., R. 40 E.) administered by the Department of Natural Resources. Decker Coal Co. has noted that their proposed alignment would provide improved access to the west shore of the reservoir. Use of the existing semideveloped recreation site would be expected to increase, due in part to greater public exposure, but mostly because of a greater number of people entering the area.

The State's Historic Preservation Officer has been contacted regarding the presence of historic or cultural sites within the alignment corridor proposed by the Decker Coal Co. The Preservation Officer indicated that no historic sites are known to exist in the vicinity of the proposed realignment (see Appendix I).

Based on a 20-year projected traffic volume of 250 vehicles per day at 50 miles per hour, with 12 percent of all vehicles being trucks, a nomograph analysis indicates that a noise sensitive location must be within 15 feet to exceed the design noise level L_{10} of 70 dBA. This level is acceptable for residences, schools, parks, and recreation areas. The nearest residence, which is owned by the Decker Coal Co., is nearly 3,000 feet from the proposed west-shore alignment.

The northernmost 2.3 miles of the Decker Coal Co.'s proposed alignment (secs. 26, 27, 28, T. 8 S., R. 40 E.) overlies federally-owned coal reserves. Because this coal has not been leased, a future relocation of this mileage might be necessary to accommodate its removal.

11. Train traffic

At full production of about 2.3 million tons of coal annually from the North Extension mine, a total of about 9 unit trains per week, 4.5 loaded and 4.5 empty, would traverse the Burlington Northern rail spur presently serving the West Decker mine. At full production of about 10 million tons annually from the West Decker mine, a total of about 38 trains per week currently pass over this line. Total traffic, including production from the North Extension mine, therefore, would be increased to approximately 47 trains per week, 23.5 loaded and 23.5 empty.

The West Decker spur line crosses Route FAS 314 at grade about 1.5 miles south of the West Decker plant area (fig. 10). Unit trains on this line, therefore, frequently obstruct traffic at that crossing.

Impacts to traffic on Route FAS 314 include (1) the inconvenience of occasional delays to normal farm-to-market traffic, mail-delivery vehicles, school buses, and Decker Coal Co. employees; (2) the more serious possible interference with emergency vehicles such as fire-fighting equipment, ambulances, or other vehicles used in emergency situations; and (3) the hazard posed by train-vehicle collisions at the road crossing. One such accident has already occurred at the crossing described above, which is protected only by flashing signals, pavement markings, and advance warning signs. Any malfunction of the signal lights would significantly increase the possibility of train-vehicle collisions.

Data furnished by the Burlington Northern Co. (Montana Department of Highways, written communication, December 29, 1976) indicate that, under normal rail-traffic conditions, a loaded unit train (100 cars, each carrying 100 tons) will block a road crossing and obstruct all traffic for a period of about seven minutes; an empty train normally blocks a crossing for a period of only about four minutes. Accordingly, unit-train traffic to and from the West Decker mine currently blocks the crossing on Route FAS 314 for approximately 30 minutes during each 24-hour period. The additional traffic from the North Extension operations would increase that period to about 37 minutes each 24 hour period.

In December 1976, a public meeting was held by the Montana Highway Department at the Squirrel Creek School near the community of Decker. The purpose of this meeting was to obtain public comment on the proposed relocation of Route FAS 314 in conjunction with the proposed North Extension operations and to assess the need for an overpass or underpass to replace the at-grade crossing of Route FAS 314 over the West Decker spur line. Local residents at this meeting emphasized the inconvenience and hazards introduced by the frequent obstruction of traffic at the crossing and testified that traffic occasionally was delayed for periods of as much as 30 minutes by equipment breakdowns or other problems.

Public comments at the December meeting are summarized in memorandum's prepared by the Montana Highway Department (Appendix K).

C. Cumulative impacts of the proposed mines

Other large surface coal mines tentatively planned in the Northern Powder River Basin would increase the magnitude of many of the impacts described for the proposed East Decker and North Extension mines. Furthermore, it may be assumed that such impacts would in many instances be greater than the cumulative impacts of the proposed and existing Decker operations. In the absence of firm proposals for other mines in the Decker and adjacent areas, however, no quantitative analysis of their cumulative impacts in conjunction with the Decker proposals is possible at this time. The following analysis, therefore, is necessarily confined largely to a discussion of the cumulative affects of the Decker Coal Co. proposals.

1. Topography

The impacts on topography are local in nature and would not be increased nor decreased as a result of the concurrent operation of the two proposed mines and the existing West Decker mine. The cumulative impacts of erosion and sedimentation that would be expected as a consequence of changes in topographic features are discussed under Erosion and sedimentation, p. 453.

2. Soils

Concurrent operation of the proposed East Decker and North Extension mines would produce cumulative impacts only on air quality and on sediment yield to the Tongue River Reservoir.

At most, the impact on air quality would be the algebraic sum of the windblown particulates derived as a result of erosion stemming from soil disturbances in the two mine areas. Very probably, however, the products of eolian erosion in the East Decker area would be deposited largely downwind to the southeast because of the prevailing northwesterly winds and would have little or no cumulative effect on air pollution in the North Extension area. Conversely, the products of eolian erosion in the North Extension area would normally be carried southeastward toward the East Decker area. The cumulative impact on air quality in the East Decker area, therefore, probably would be somewhat less than the total of the products of eolian erosion in the two areas.

The cumulative impacts of erosion and sedimentation and their effect on the Tongue River Reservoir are discussed on p. 453.

3. Water resources

a. Effects on ground water

Concurrent operation of the proposed East Decker and North Extension mines would produce cumulative impacts on the quality and supply of ground water primarily in those instances where the separate impacts affect the same general area or hydrologic feature, such as the Tongue River Reservoir. The cumulative impacts in these instances probably can best be described as the algebraic sum of the impacts of the individual mining operations.

(1) Removal of parts of certain aquifers

Concurrent operation of the two proposed mines would result essentially in the simultaneous removal and replacement of aquifers within the separate mine areas, as indicated in the following table:

	Approximate area to be removed (mi^2)		
Aquifer	East Decker area	North Extension area	Total
Anderson coal	2	1	3
Dietz 1 coal	3.5	1	4.5
Dietz 2 coal	<2	2	4
Sandstone	2	---	<2
Clinker	1.5	1.5	3
Alluvium	$<.5$	.5	.5 - 1.0

In this instance, the cumulative impact would be to the area and represents the removal and replacement of aquifers in a shorter time frame than would occur if the mines were not operated concurrently. The total area of aquifers removed and replaced, however, would not be increased or decreased by concurrent operation of the two mines.

(2) Interruption of ground-water flow by the pits

As the East Decker and North Extension areas have essentially unrelated ground-water systems that discharge to and are separated by the Tongue River Reservoir, concurrent mining in these two areas would not change the rate of inflow into the proposed mines from their respective watersheds or from removal of ground water from storage. Also, ground-water inflow to the mines from the reservoir would be recirculated to the reservoir by pumps, thereby negating any direct cumulative impact on the reservoir contents from this effect. Cumulative impacts, therefore, would be limited to (1) reduction of ground-water discharge to the reservoir by an amount equal to the combined use of water in the two mining operations and (2) increased ground-water discharge to the reservoir by an amount equal to the combined rate of removal of water from storage. Use of water would be about 60,000 gal/day in the East Decker area (p. 39) and an undetermined, but lesser amount in the North Extension area. Total use probably would not exceed about 100,000 gal/day (0.3 acre-ft/day). Removal of ground water from storage initially should be at least 0.1 ft^3/s (60,000 gal/day) in the East Decker area (table 34) and 0.4 ft^3/s (250,000 gal/day) in the North Extension area (table 39). Thus, concurrent operation of the two mines initially should result in a net gain to the reservoir of about 200,000 gal/day (0.6 acre-ft/day). The amount of water removed from storage should decrease progressively with time, but very probably would not become less than the amount used in the respective mining operations. Interruption of ground-water flow by the concurrent operation of the two mines, therefore, should have no adverse impact on the volume of water in or the water level of the Tongue River Reservoir.

(3) Modifications of ground-water flow by replaced spoil materials

As previously stated (p. 322), drag-line laid materials, which would compose the great bulk of the spoil in both the East Decker and the North Extension areas, should be more permeable than the parent rocks. The course rubble layer at the base of the spoils (fig. 44) should be especially permeable. Accordingly, very little water would be expected to accumulate in the spoil materials above the level of dewatering in the active pits during the life of the proposed mines, regardless of their temporal relationships. When pumping to dewater either of the proposed mines is discontinued, the effect would be to abruptly cease discharge from the mine to the reservoir and simultaneously begin the process of saturating the mined and adjacent dewatered area to a level where ground-water flow to the reservoir eventually would resume at approximately the premining rate. In the interim, the loss of water to the reservoir would be twofold; (1) recharge to the mine area from the watershed, both from surface and ground-water sources, would no longer be discharged to the reservoir by pumping and (2) inflow to the dewatered areas would occur from the reservoir.

Should the two proposed mining operations be discontinued simultaneously, which is unlikely, the loss of water to the reservoir could be as much as 18 to 24 acre-ft/day (about 2 percent of inflow to the reservoir on an annual basis). Should the two proposed mines and the existing West Decker mine be discontinued simultaneously, the loss of water to the reservoir could be as much as 20 to 30 acre-ft/day (about 2.5 percent of inflow to the reservoir on an annual basis).

The rate of inflow from the reservoir to the dewatered areas would be maximum at high reservoir stages and minimum at low stages. Inflow to the mined areas generally would decrease progressively over a period of as much as 15 years, eventually ceasing when the level of saturation in the dewatered areas corresponds to reservoir level.

Very probably mining would not be discontinued simultaneously in the existing and proposed mines in the Decker area. Therefore, periods of maximum inflow to the respective mined areas from the Tongue River Reservoir would not coincide. If so, the cumulative effect would be to reduce the water loss to the reservoir to less than 2 percent of the annual inflow volume. The period over which the loss would occur, however, would be expanded accordingly.

(4) Changes in water quality caused by leaching of spoil materials

The effects of leaching of spoil materials on the quality of ground water in the respective mine areas would be unaltered by the concurrent operation of all three mines. The flow systems in the three mine areas are virtually independent; therefore, factors controlling leaching by ground water in each of the areas are equally independent. As a result, the quality of ground water that would occur in or be discharged from the respective mine areas would be the same as previously described, regardless of whether one, two, or three mines are operated concurrently.

(5) Changes in water quality in the Tongue River Reservoir and impacts on downstream irrigation

Although concurrent operation of the existing and proposed mines would not change the quality of water discharged from the individual mines, the simultaneous release of mine effluent into the Tongue River Reservoir would introduce some cumulative changes in the quality of water in the reservoir. To evaluate these changes, consideration must be given to the volume and dissolved solids content of inflow to the reservoir and to the mixing and dilution that would occur in the reservoir.

The largest source of inflow to the reservoir is the Tongue River, the quality of which essentially determines the quality of the reservoir water. Concurrent streamflow and water quality data have been collected by the U.S. Geological Survey since 1965 at a gaging station on the Tongue River near the state line (p. 191). Mass balance calculations, based on inflow to the reservoir from the Tongue River and from the existing and proposed mine areas, were made to determine the cumulative effects of discharging mine effluent to the reservoir. Results are summarized in table 44 and shown graphically in figure 65.

These results show that greatest impact to the quality of water in the reservoir should occur during mining rather than after reclamation. The cumulative effects during mining, would be so small as to have virtually no detrimental effect on the use of the reservoir or its water. Even in August when dilution of the mine effluent in the reservoir would be at a minimum, the addition of mine effluent to the reservoir should not significantly impair the downstream use of the water for irrigation. These conclusions generally reinforce those of Van Voast and Hedges (1975, p. 28) who conclude that hypothetical average changes in river quality as a result of surface mining in the Decker area would be insignificant and would be difficult to detect in the laboratory.

Table 44.--Cumulative impact of mine discharges on the quality of water in the Tongue River Reservoir

	Premining			During mining			Postmining		
	Inflow[1/] (Acre-ft/day)	TDS (mg/l)	SAR	Inflow[1/] (Acre-ft/day)	TDS (mg/l)	SAR	Inflow[1/] (Acre-ft/day)	TDS (mg/l)	SAR
Jan.	395	754	1.0	422	830	1.5	395	792	1.3
Feb.	592	697	0.9	619	751	1.2	592	722	1.0
Mar.	880	772	1.1	907	807	1.3	880	789	1.2
Apr.	826	768	1.2	853	805	1.5	826	786	1.3
May	2492	480	0.7	2519	495	0.8	2492	486	0.8
Jun.	3912	290	0.5	3939	301	0.6	3912	293	0.6
Jul.	1007	498	0.9	1034	535	1.1	1007	513	1.0
Aug.	378	735	1.4	405	814	1.8	378	774	1.6
Sep.	554	658	1.1	581	717	1.4	554	684	1.3
Oct.	584	699	1.0	611	754	1.3	584	725	1.2
Nov.	515	731	1.1	542	790	1.5	515	759	1.3
Dec.	410	760	1.0	437	832	1.5	410	796	1.3
Avg.	1046	526	0.9	1073	561	1.1	1046	540	1.0

[1/] Composite of Tongue River at State line and discharge from the existing and proposed mining areas.

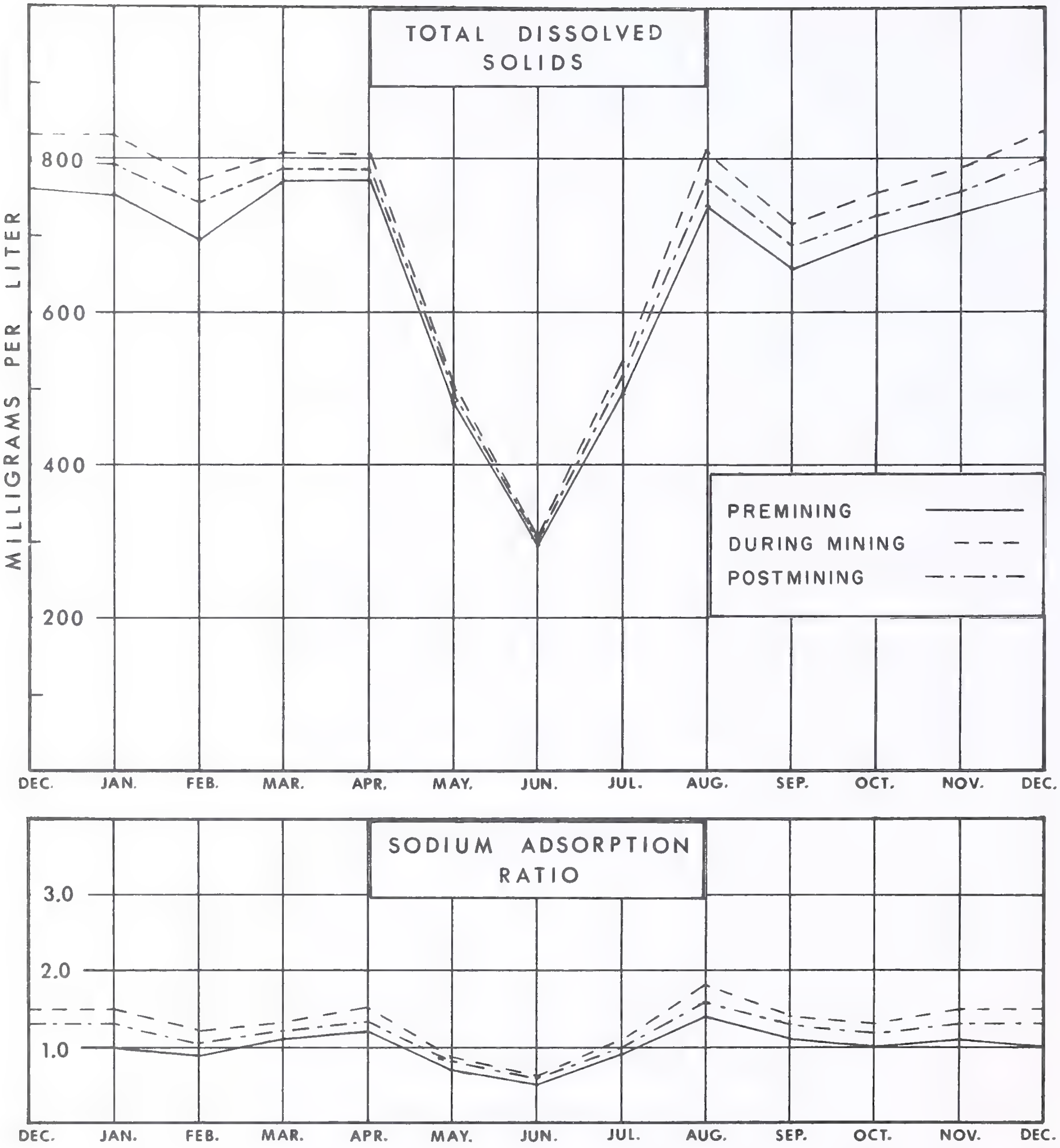

Figure 65.-Cumulative effects of ground-water discharge from the East Decker and North Extension mines on the quality of water in the Tongue River Reservoir.

They state that "During some months, the hypothetical chemical differences would be somewhat greater * * * but would produce no effect that would reduce the useability of the river for irrigation or fish and wildlife habitat."

(6) Effects of blasting

Repeated blasting to loosen overburden, interburden, and coal during the simultaneous operation of the existing and proposed mines would increase the frequency of consequent small seismic shock waves in the Decker area. The distances separating the epicenters, however, should preclude any significant increase in the intensity or the damaging effects of these disturbances, even in the unlikely event that blasting should occur simultaneously at all three mines.

The concurrent introduction of nitrate into the mine effluents probably would not be detectable after mixing with reservoir waters because of the extreme dilution that would occur.

(7) Changes in water levels

Concurrent operation of the West Decker, East Decker, and North Extension mines would require simultaneous pumping to dewater the active pits. This pumping would simultaneously lower water levels in wells located within the areas influenced by pumping in each of the mine areas. Additional declines in water levels caused by concurrent operation of the existing and proposed mines would occur only in those local areas where the effects of pumping from two or more mining centers overlapped.

No cumulative or additional declines in water levels beyond those described for the respective proposed mines are expected in wells completed in alluvium, clinker, or overburden, owing to the limited extent of the area affected by pumping from these aquifers. Wells finished in the

Anderson and Dietz 1 coal beds should not experience cumulative declines because these aquifers lack hydraulic continuity between mine areas. The Dietz 2 coal bed, however, is continuous throughout most of the Decker area, and a possibility exists that the areas influenced by pumping at the West Decker and North Extension mines could locally overlap. Should this occur, the decline in water level in a well adversely affected would be the sum of the declines caused by pumping in the nearby mine areas. It is unlikely that the effects of pumping in the East Decker mine would extend beneath the reservoir to the West Decker and North Extension areas and vice versa.

Additive declines in water levels caused by overlapping of the areas of influence of simultaneous pumping during concurrent operation of the three mines probably would occur only in one well that obtains water from the Dietz 2 coal bed (no. 51 table D-1, Appendix D). This well is located in the SE¼SW¼ sec. 10, T. 9 S., R. 40 E., between the existing West Decker and the proposed North Extension mines. It is owned by the Decker Coal Co. and is no longer in general use.

b. Effects on surface water

Concurrent operation of the proposed East Decker and North Extension mines would produce cumulative impacts on the quantity and quality of surface-water supplies and on sediment yield only in those instances where the separate impacts affect the same general area or hydrologic feature, such as the Tongue River Reservoir. The cumulative impacts in these instances probably can best be described as the algebraic sum of the impacts of the individual mining operations.

(1) Alteration or removal of existing stream channels

Concurrent operation of the two proposed mines would result essentially in the simultaneous alteration or removal of all natural stream channels within and adjacent to the separate mine areas, as indicated in table 45.

Table 45. -- Disturbance of existing stream channels in the Decker area under the proposed mining plans

Stream channel	Type of disturbance	Length of valley to be disturbed (miles)	Average valley slope[1]	Average channel slope[2]
EAST DECKER AREA				
Deer Creek	Channel to be locally filled with spoils	2.1	0.0053	0.0030
Middle Creek	Channel to be removed	1.7	.011	.0076
Coal Creek	Channel to be removed	1.1	.013	.0098
Other unnamed streams[3]	Channels to be removed	9.2	.022	.020
NORTH EXTENSION AREA				
Spring Creek	Channel to be removed	1.4	0.010	0.0074
South Fork Spring Creek	Channel to be removed	.3	.009	.0080
Pearson Creek	Channel to be removed	2.0	.011	.0070
Other unnamed streams[4]	Channels to be removed	3.5	.018	.017

[1] Measured on valley floor along centerline of valley.

[2] Measured along meandering course of stream channel.

[3] Includes measurements of 14 small ephemeral stream valleys.

[4] Includes measurements of 6 small ephemeral stream valleys.

In this instance, the cumulative impact would be to the overall area and represents the alteration or removal of the stream channels in a shorter time frame than would occur if the mines were not operated concurrently. The total length of channels altered or removed, however, would not be increased or decreased by the concurrent operation of the two mines.

(2) Interception and diversion of runoff

The surface-water flow systems and thus the interception and diversion systems proposed in the East Decker and North Extension areas are wholly independent. Concurrent operation of the two proposed mines, therefore, would not alter the individual impacts previously described for the respective mining operations. Consequently, the cumulative effect of mining on the quantity and quality of water and the amount of sediment yielded to the Tongue River Reservoir would be the algebraic sum of the individual impacts of the two operations. These cumulative effects are described on page 453.

Conversely, the interception and diversion systems in the North Extension and West Decker areas are not independent. Runoff from the Pond Creek watershed upstream from the existing West Decker mine is currently diverted into the Pearson Creek drainage. On completion of mining in the West Decker area, the Pond Creek diversion will be removed and runoff from the Pond Creek watershed will be returned to a channel constructed across the reclaimed mine area. Thus, concurrent operation of the existing West Decker mine and the proposed North Extension mine would result in an increase in discharge and sediment in the Pearson Creek diversion channel downstream from the mouth of the Pond Creek diversion (tables 16 and 18). This increased discharge could augment erosion in the diversion channel as it is presently designed, and thereby increase the sediment yield to the Tongue River Reservoir.

(3) Changes in quantity of water

It is estimated that the concurrent operation of the East Decker and North Extension mines would reduce water yield to the Tongue River Reservoir by no more than about 165 acre-feet annually during mining and about 85 acre-feet annually after mining (table 46). This loss of water to the reservoir represents less than five-hundredths of 1 percent of total annual inflow to the reservoir during the period of mining and less than three-hundredths of 1 percent of total annual inflow to the reservoir after mining.

It is estimated that concurrent operation of the proposed East Decker and North Extension mines and the existing West Decker mine would reduce water yield to the Tongue River Reservoir by no more than about 230 acre-feet annually during mining and about 125 acre-feet annually after mining. This loss of water to the reservoir represents less than seven-hundredths of 1 percent of total annual inflow to the reservoir during the period of mining and less than four-hundredths of 1 percent of total annual inflow to the reservoir after mining.

(4) Changes in chemical quality of water

No measurable changes in the chemical quality of surface runoff to the Tongue River Reservoir is expected in response to the concurrent operation of the two proposed mines and the existing mine in the Decker area. The estimated dissolved solids content of water pumped from the mines is discussed on pages 330 and 393. The impact of this water on the Tongue River Reservoir is described on page 444.

Table 46.--Estimated changes in average annual runoff and sediment yield as a result of mining in the East Decker and North Extension areas.

Source	Drainage area (mi^2)	Average annual runoff (acre-ft)	Average annual runoff: Change from premining[1] (acre-ft)	Average annual runoff: Change from premining[1] (percent)	Average annual sediment yield (acre-ft)[2]	Average annual sediment yield: Change from premining[1] (acre-ft)	Average annual sediment yield: Change from premining[1] (percent)
PREMINING							
Tongue River at State line	1,480	357,000	-------	-------	238	-------	-------
East Decker streams	62	1,040	-------	-------	19	-------	-------
North Extension streams	48	640	-------	-------	18	-------	-------
Other tributaries	180	2,900	-------	-------	53	-------	-------
Total to Tongue River Reservoir	1,770	361,580	-------	-------	328	-------	-------
DURING MINING[3]							
Tongue River at State line	1,480	357,000		0	238	0	0
East Decker streams	62	915	-125	-12	20	[4]+1	+ 5
North Extension streams	48	600	- 40	- 6	16	[4]-2	-11
Other tributaries	180	2,900	0	0	53	0	0
Total to Tongue River Reservoir	1,770	361,415	-165	- .05	310	[4]-1	- .3
POSTMINING[3]							
Tongue River at state line	1,480	357,000	0	0	238	0	0
East Decker streams	62	975	- 65	- 6	50	[5]+ 31	+160
North Extension streams	48	620	- 20	- 3	100	[5]+ 82	+450
Other tributaries	180	2,900	0	0	53	0	0
Total to Tongue River Reservoir	1,770	361,495	- 85	- .02	441	[5]+113	+ 34

[1] Assumes only those mitigating measures described in the proposals.

[2] Sediment weight assumed to be 70 lb/ft .

[3] Assumes no change in average annual flow and sediment yield of the Tongue River from premining rate.

[4] Annual sediment yield would be lowest initially and probably would increase progressively as mining continues.

[5] Estimated average annual sediment yield during period of rapid channel adjustment after completion of mining operations. Eventually over a period of decades or possibly centuries, annual sediment yield should return to approximately premining rates.

(5) Erosion and sedimentation

Because the surface-water flow system in the East Decker and North Extension areas are wholly independent, the concurrent operation of these two mines would not increase or decrease the impacts previously described for the individual operations. The sediment yield to the Tongue River Reservoir, therefore, would be the algebraic sum of the concurrent sediment yields from the two mine areas. On that basis, it is estimated that the sediment yield to the reservoir might be reduced as much as 20 acre-feet annually during the first 5 to 10 years of concurrent mining. Thereafter, the sediment yield to the reservoir would probably increase progressively such that the average sediment yield to the reservoir over the life of the operation might equal or slightly exceed the premining rate.

After mining and reclamation operations are completed, the sediment yield to the Tongue River Reservoir probably would increase dramatically to more than 100 acre-feet annually during the period of channel readjustment for those streams that would enter the mined area over the highwall or that would be otherwise altered by mining. Total long-term sediment yield to the reservoir as a result of mining could be increased by more than 5,000 acre-feet. It should be noted, however, that these large quantities of sediment would be obtained almost entirely from valley trenching upstream from the final highwall. This accelerated erosion could be largely, if not wholly, prevented with appropriate mitigating measures (p. 556-561).

Large volumes of sediment would significantly reduce the water storage capacity of the Tongue River Reservoir, thereby decreasing the effectiveness of this structure for flood control and its utility as a storage facility for downstream irrigation.

c. An enlarged Tongue River Reservoir

The impacts of an enlarged Tongue River Reservoir on mining activities in the East Decker and North Extension areas would not be significantly increased or decreased as a result of the concurrent operation of the two proposed mines. The cumulative impacts on an enlarged reservoir of operating the two mines concurrently should be the sum of the impacts previously described for the East Decker and the North Extension mines (see sections A.3 and B.3). Specifically, impoundment of water to stage I (3,438 feet, fig. 21) would cause appreciable bank erosion in the absence of protective measures along the access road and railroad to the East Decker mine and along relocated Route FAS 314 in the North Extension area. Comparatively little erosion of spoil materials would occur in either the East Decker or North Extension areas because spoils would be placed largely above reservoir level. Loss of reservoir capacity from deposition within the reservoir basin of the products of this erosion might be as much as 10 acre-feet annually, which is about 3 percent of the amount of sediment contributed to the reservoir annually from all other sources.

Movement of water into the reclaimed spoil materials as bank storage during periods of high reservoir water levels and drainage back to the reservoir during periods of low levels is expected to increase the rate of leaching of the spoil materials and the volume of solutes entering the enlarged reservoir. Very probably, however, this input would be largely offset by the dilution afforded by the larger reservoir contents (fig. 22). It is doubtful that any adverse effect of this added leaching of the spoil materials on the quality of water in the reservoir would be measurable by present methods and standards.

Impoundment of water to stage II (3,453 feet, fig. 21) would cause locally severe bank erosion on reclaimed spoils materials and would probably pose a major environmental impact that would require protective measures. In the absence of those measures, sediment yield to the reservoir and consequent loss of capacity could exceed 100 acre-feet annually. Discoloration of the water from suspended sediment could significantly impact the recreational value of the enlarged reservoir.

Movement of water into and out of the spoils in response to reservoir water-level fluctuations would probably further increase the rate of leaching of these materials, but the products of this leaching would be diluted in the larger reservoir contents. As previously indicated for a stage I reservoir, therefore, it is doubtful that any adverse effect of this additional leaching on the quality of water in the reservoir would be measurable by present methods and standards.

4. Air quality

The addition of two large strip mines in the Decker area would add more particulates, fugitive dust, and gaseous emissions to the air. As discussed in sections III. A. 4. and III. B. 4., such emissions, if uncontrolled, would have an adverse impact on the existing air quality.

The need for adequate control of air pollutants related to strip mining is accentuated when one considers that by 1978 three large surface coal mines may be operating in the Decker area basin. Should a surface inversion persist in these basins for a period of several days or a few weeks, cumulative ground-level pollutant accumulations probably would significantly exceed the pollution caused by any one of the three mining operations.

The cumulative effects of the indirect-source emissions associated with the increased motor-vehicle travel resulting from the proposed new mines also represents an additive sum. Such a cumulative effect, however, is minimal. With all three Decker mines in operation, maintenance and production labor would not in all probability exceed 640 employees. This total number of workers, as related to the generated motor-vehicle volumes, is still well below the criteria defined by the EPA for indirect-source planning.

Cumulative impacts caused by road-relocation construction at the two proposed mine sites is not expected to add significantly to the degradation of the Decker area air quality.

5. Vegetation

a. Existing vegetation destroyed

On completion of the proposed projects, approximately 4,000 acres of native vegetation would have been removed by mining and associated activities at the two mine sites over a period of about 20 years. Attempts to revegetate these areas to their approximate premining condition would be at various growth and successional stages. The native vegetation destroyed at the East Decker and North Extension mines would approximately triple the acreage of the native vegetation that would be disturbed in the Decker area by the existing mine.

By mining additional acreage, ultimate reclamation success becomes more critical. It is too early to adequately evaluate the success of reclamation attempts on strip-mined lands in the Decker area. Vegetation communities established on mined areas at the West Decker mine, however, bear little resemblance to the "permanent and diverse" vegetative cover required by the Montana Strip and Underground Mine Reclamation Act (Section 50-1045 R.C.M. 1947). Instead, such areas currently are heavily invaded by silverscale saltbush (annual) and summer-cypress; these species are representative of an early or pioneer stage of vegetative succession.

Certain native plant species or communities might be eliminated from reseeded areas for perhaps hundreds of years owing to failure of proposed reclamation practices to duplicate all premining topo-edaphic conditions. Silver sagebrush, for example, is a deep-rooted species that has relatively high moisture requirements. In eastern Montana silver sage tends to grow primarily on alluvial valley floors. In the proposed permit areas silver sage occurs primarily along drainage courses (i.e., Deer Creek, Middle Creek, and Spring Creek channels). Proposed mining and subsequent reclamation activities in the East Decker and North Extension areas would eliminate these alluvial drainages, remove the deep alluvium, and thus destroy existing topo-edaphic conditions that favor the growth of silver-sage communities. Possibly in the future, after processes of erosion and deposition have locally increased soil depths on the reclaimed acreage, these communities may become reestablished. In the foreseeable future, however, communities or species relying on deep alluvium probably would be lost.

Increased human population in the Decker area, a cumulative impact, would also affect vegetation insomuch as foot and vehicle travel would undoubtedly increase on adjacent rangelands. Improper use of off-road recreational vehicles, for example, is particularly effective in causing long-term damage to vegetation. Ruts are cut in the land surface, thus destroying vegetative cover, removing soil, and augmenting erosion. Such human disturbances, if severe, could significantly damage land outside the proposed mine boundaries as an indirect result of coal production in the Decker area.

b. Impacts on grazing and agriculture

Cumulative impacts on grazing and agriculture represent the sum of the impacts resulting from both mine proposals. These impacts are discussed in sections III. A. 6. and III. B. 6. Such impacts include the loss of approximately 440 acres of irrigated cropland and the loss of an estimated 1,000 AUMs for the 20-year life of the mines.

The Decker Coal Co. proposes to fence a total of 6,040 acres and remove them from agricultural production for the life of the mines. Only a portion of this area would actually be mined. The displacement of this land would reduce the total output of farms and ranches in the area. The decline in gross farm receipts is optimistically projected to be about $95,000 (1970 dollars) per year. The adverse economic impact of this action would be relatively minor (Polzin, 1975). The 6,040 acres is only slightly larger than the average farm or ranch in the socio-economic impact area, and the projected declines in gross farm receipts represents about 0.4 percent of the reported total in Big Horn County during 1973 (Montana Department of Agriculture and U.S. Statistical Reporting Service, 1974).

Undisturbed vegetation within the proposed mine boundaries, much of which is overgrazed, would benefit from the exclusion of domestic grazing over the 20-year life of the projects.

c. Effects of dust on vegetation

Soil and coal dust (air-borne particulates) could have detrimental effects on vegetation in unmined or on reseeded areas. Dust sources are discussed on page 361, dust impacts on vegetation are discussed on page 367. The potential for mine-related dust to impact vegetation in the Decker basin will increase with the opening of the two proposed mines.

6. Wildlife

Total acreage to be directly affected by strip mining in the Decker vicinity, including the existing West Decker mine, would total approximately 9,200 acres if the two proposed mines are approved. The rate at which the total reclaimed surface would again be usable as productive wildlife habitat depends on the cumulative impact of all three mines.

Not all 9,200 acres would be affected at once. Areas within the respective mine boundaries may serve as habitat for wildlife up to the time of physical disturbance and may return to usable habitat on satisfactory completion of the reclamation activities. Should revegetated areas not be returned to approximate premining natural range conditions, 9,200 acres of habitat for many species would have been sacrificed for coal production.

a. Mammals and birds

With regards to the East Decker and North Extension mines, cumulative impacts for most mammals and birds represent the cumulative sum of the impacts mentioned for each of the proposed mines (see sections III. A. 6. and III. B. 6.). Such impacts include:

1. The removal of potential feeding, fawning, resting and wintering habitat for mule deer.

2. Increased chances of poaching and wildlife-vehicle collisions for all species and especially for mule deer, white-tailed deer and antelope.
3. Possible localized increases in game species that would utilize areas within the fenced mine boundaries (i.e., mule deer, p. 368 -369).
4. Displacement of antelope and reduction in year-round habitat for antelope.
5. Reduction in sage-grouse numbers as a result of their intolerance to human activity and the destruction of large amounts of sagebrush and removal of a sage-grouse strutting ground.
6. Removal of alfalfa as a food and cover source for sharp-tailed grouse and other species.
7. A slight reduction in riparian habitats utilized by white-tailed deer and pheasants.
8. Removal of seasonal stubble fields utilized as feeding areas for Canada geese.
9. Possible decline in hunting pressure on waterfowl utilizing the Tongue River Reservoir inasmuch as mine-safety requirements do not allow hunting within mine areas.
10. Possible increase in accidental bald and golden eagle deaths from the construction of power lines. Mining would also slightly reduce the size of hunting areas for these large birds.
11. Loss of habitat for many nongame species. During the mining process, about 4,000 acres of small mammal habitat would be

destroyed as a consequence of mining. This would result in a decline in the number of small mammals that make up the primary consumer populations. Nongame animals most affected by habitat loss include the western deer mouse, mountain cottontail, white-tailed jackrabbit, Richardson's ground squirrel, black-tailed prairie dog, sagebrush vole, northern pocket gopher, and Ord's kangaroo rat. Nongame animals least affected would be those existing primarily in vegetative community types not present in the actual mining areas (VTN Colorado, 1975a, 1975b). These include animals associated with the ponderosa-pine badlands. These animals may suffer increased population losses through the increased hunting pressures of secondary consumers when primary consumers in the mining area are no longer available as a food source (VTN Colorado, 1975a, 1975b).

Mine operations would decrease available nesting and feeding areas for many of the resident song and insectivorous birds in the Decker area. The density of breeding birds within the proposed mining areas does not appear to be heavy, and it is possible that displaced birds would use areas outside the mined area for nesting and feeding.

b. Fish

Cumulative impacts to the fishery of the Tongue River Reservoir are the sum of the impacts caused by both proposed mines (see sections III. A. 6. and III. B. 6.). Potential for leaching of toxic elements from mine spoils, increased sediment load, and toxic mine-water discharge are all approximately double that for a single mine.

7. Populatation (Fitzpatrick, 1975)

a. Developmental assumptions

The assumptions used to develop population projections are listed below. A fuller explanation of these assumptions is found in Appendix G.

1. Population change is the product of birth, death, and migration.
2. Economic development (i.e., the proposed Decker mines) is considered a major impetus for population change.
3. Estimates of population change attributable to the Decker mine proposals consider both the direct and indirect employment effects of the mines.
4. Mine work and railroad employment is considered a basic component of the local economy. All other jobs used in these projections are considered derived. Table 47, showing the estimated mine-related employment of the proposed new Decker mines, is a vital component of this assumption.
5. All basic jobs (i.e., mine and railroad) are filled by in-migrating workers.
6. Derived jobs are filled by inmigrating males and females. Women employees participate in the labor force in derived jobs. Forty percent of the married workers are female. Estimation procedures consider households and single individuals as input variables. Married women are a component of households. Calculation of the "derived population" requires subtraction of the number of married female workers from total full-time derivative employment.

Table 47.--Estimated mine-related employment, proposed North Extension and East Decker mines[1]

	1976	1977	1978	1979	1980 - 2000[4]
North Extension					
Preparation[2]	50	0	0	0	0
Operations	70	70	70	70	70
Railroad	5	5	5	5	5
Derived[3]	140	100	90	90	80
East Decker					
Construction	165	215	65	0	0
Operations	0	0	200	250	270
Railroads	0	0	20	25	27
Derived[3]	100	130	320	320	340

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[1] Source: Decker Coal Co., written communication, July 30, 1975. Estimates of railroad and derived employment were calculated for the economic analysis of the Sheridan-Decker area. A description of the economic methodology is located in Appendix G. Estimates of derived employment are considered preliminary at this time. Additional information may necessitate their revision.

[2] Preparatory workers are construction workers differentiated from other construction workers on the basis of skill. Preparatory workers are principally heavy equipment operators involved in building ramps, diversion dams, removing top soil, etc.

[3] Estimates of derived employment are only for full-time jobs. Part-time employment is attributed to the existing population. It is not considered a variable in estimating population.

[4] Labor-market adjustments after 1980 would affect the level of derived employment. For simplicity's sake, these adjustments are ignored.

7. The migrant population attracted to the impact area will illustrate slightly different population characteristics when compared with the existing population.

   The salient differences appear to be or include:

   a. Inmigrants are assumed to be between the ages of 18 and 65 years (i.e., working age).
   b. The median age of the inmigrant population is assumed to be at or near the national median age of 28.1 years.
   c. Given the relative age of the inmigrants, it is further assumed that a higher proportion would be married.
   d. All inmigrants are assumed to be Caucasian.
   e. Age differences between inmigrants and residents implies a larger sized family for inmigrants.

8. Fifty percent of the inmigrating construction workers would be married with 1.5 children per married couple. Eight percent of the inmigrating operational mine workers, railroad, and derivative employees would be married with 1.5 children per married couple.
9. Each married couple would have 1.125 school-aged children.
10. The inmigrating population would be distributed in a manner similar to the existing work force and population associated with the Decker Coal Co. That is 90 percent of the inmigrants would settle in Sheridan County. The majority of these people would settle in the city of Sheridan. The remaining inmigrating population (10 percent would settle in Big Horn County).

11. No other coal or industrial development would occur within the impact area boundaries (especially in the vicinity of Sheridan).[1/]

12. With the exception of inmigration associated with the proposed Decker mine expansion, net migration is assumed to be zero in Big Horn and Sheridan Counties. Rosebud County would not experience population change attributable to the proposed Decker projects. For all counties, the natural increase is assumed constant at 1970-1974 levels.

b. Population change

The assumptions outlined in the preceding section serve as the basis for estimating population change in the impact area. Table 48 represents calculations of future population by mine. The demographic impact of each mine is further subdivided by employment sector. A population peak is indicated in 1980 with an anticipated increase of 1,900 persons. The proposed East Decker operation would be responsible for approximately 80 percent of the Decker related population growth. The proposed North Extension mine would contribute the remainder.

[1/] The development of a population project is an attempt to foretell the future. To do so with any reasonable assurance of accuracy, it is necessary to specify, as well as possible, the variables or events which may influence the future. Unless these variables can be specified with some degree of certainty, careful scientific analysis demands that they be disregarded.

The population projections presented in this statement were developed in response to the April and June 1975 permit applications for the East Decker and North Extension mines, respectively. Including the possible or potential effects of other mines and developments would not be proper, given the uncertainty introduced by the fact that no firm commitments to open additional mines or initiate other industrial developments had been made at the time the impact statement was prepared.

Table 48.--Mine related population (Fitzpatrick, 1975)

	1976	1977	1978	1979	1980 - 2000[2]
East Decker (total)	561	728	1,411	1,428	1,531
Construction	373	485	148	0	0
Operations	0	0	500	750	810
Railroad	0	0	60	75	82
Derived	188	243	603	603	639
North Extension (total)	601	413	394	394	371
Preparation[1]	113	0	0	0	0
Operations	210	210	210	210	210
Railroad	15	15	15	15	15
Derived	263	188	169	169	146
Total, East and North	1,162	1,141	1,805	1,822	1,902
Construction	486	485	148	0	0
Operations	210	210	810	960	1,020
Railroad	15	15	75	90	97
Derived	451	431	772	772	785

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[1] Population figures in the rows designated by the words preparation or construction reflect population levels related to mine construction jobs. Population levels associated with mine operations, railroad transport of coal, and derived employment are also designated.

[2] By 1980 population levels attributable to the Decker mine projects are considered stable. No Decker mine related population change is forecast for the remainder of the century.

Population growth related to mine expansion would fluctuate somewhat from year to year as construction phases are terminated and the mines are brought on stream. Adjustments in the local labor market would gradually change the secondary or derived impact of the mines. Initially, the employment multiplier is expected to be slightly higher than in the 1980's (table 48). This phenomena has the effect of raising population estimates to higher levels in the early years of the projected time sequence. It also accounts for the ever-diminishing population effect of the mines.

Table 49 presents population estimates on a county basis. Sheridan County has been attributed 90 percent of the mines' population impact; Big Horn County is projected to receive 10 percent. Rosebud County is not expected to experience a measurable amount of population change because of the proposed Decker mines. Population growth in Sheridan County is estimated to increase by approximately 1,000 persons by 1977 and by 1,700 people by 1980. Population growth in Big Horn County as a result of the Decker mine expansions is estimated to be 100 to 190 persons during the same period. Natural increase is a relatively insignificant component of population change in Sheridan County. This is not so, however, in Big Horn County where one year's growth from natural increase is equivalent to almost three-fourths of the mine-related population in the peak year of 1980.

The projected increase in school-age population as a result of the mine expansions is presented in table 50. Again, Sheridan County is attributed 90 percent of the increase. The increase in the number of school-aged children would range from 282 to 504 in Sheridan County and from 31 to 56 in Big Horn County.

Table 49. -- County population (Fitzpatrick, 1975)

	1975	1976	1977	1978	1979	1980	1981-20006/
Sheridan County total1/	19,619	20,684	20,684	21,301	21,335	21,426	NA
Base population2/	19,600	19,619	19,638	19,657	19,676	19,695	NA
Natural increase3/	19	19	19	19	19	19	NA
East Decker	NA	505	655	1,270	1,285	1,378	1,378
North Extension4/	NA	541	372	355	355	334	334
Big Horn County total	10,631	10,880	11,013	11,215	11,355	11,503	NA
Base population	10,500	10,631	10,764	10,899	11,035	11,173	NA
Natural increase	131	133	135	136	138	140	NA
East Decker	NA	56	73	141	143	153	NA
North Extension	NA	60	41	39	39	37	37
Rosebud County total5/	9,357	NA	NA	8,137	NA	7,862	NA

1/ Total population computed by adding together population components for base population, natural increase, and mine expansion. Ninety percent of the mine population is attributed to Sheridan County and 10 percent to Big Horn County.

2/ Base population for 1975 derived by projecting the 1970-74 rate of change one additional year. Thereafter, base population increases at a rate corresponding to natural increase.

3/ Natural increase is the excess of births over deaths. The Sheridan County rate of natural increase is assumed constant at 0.1 percent per year. Big Horn County has an assumed rate of natural increase at 1.25 percent per year.

4/ The population estimate reported for the East Decker and North Extension mines is total population. It includes population associated with mine construction and operation, railroad transport, and derivation employment.

5/ The Rosebud County total is drawn from estimates prepared for the Montana Department of Natural Resources and Conservation. The figures include population growth associated with the construction and operation of Colstrip units #1 and #2, expansion of the Western Energy mine, and natural increase (See Montana Department of Natural Resources and Conservation (1974 p. 771-779).

6/ Natural increase, base, and total county population is not presented after 1980. Estimates of natural increase become increasingly speculative by that date. Mine-related population is considered stable for the years 1980 - 2000.

Table 50.--School children (Fitzpatrick, 1975)[1]

	1976	1977	1978	1979	1980	1981 - 2000[3]
Total school children	318	313	524	537	560	560
Sheridan County total[2]	286	282	471	483	504	504
East Decker	132	172	387	379	406	406
North Extension	154	110	104	104	93	98
Big Horn County total	32	31	53	54	56	56
East Decker	15	19	41	42	45	45
North Extension	17	12	12	12	11	11

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[1] Assumes 1.125 school age (i.e., 6-18 years old) children per married couple.

[2] Ninety percent of the school children is allocated to Sheridan County, 10 percent is allocated to Big Horn County.

[3] By 1980 the number of school-aged children is considered stable and projected at a constant level until the turn of the century.

c. Qualifications and reservations

The population estimates of the preceding section are an attempt to foretell the future. They are not absolute. The output of any modeling technique is contingent on the nature of the inputs. The assumptions and input criteria of this model have been specified. Future population estimates have been derived accordingly. Nevertheless, some qualifications are necessary. First, the assumption of 1.5 children per married couple is drawn from research conducted outside the Sheridan area and "preliminary" site-specific information. This assumption might be in error. Adjustments will be made as dictated by updated information. Second, derived employment is difficult to calculate. The adjustment mechanisms of a local economy are difficult to specify. It is even more difficult to accurately translate derived employment into population change. Third, in the absence of other major industrial developments, it is doubtful that Big Horn County would maintain its recent trend of growth. Net outmigration would substantially enlarge. Population would not continue to grow at a rate near that for natural increase.

Fourth, mine hiring presents the appearance of hiring local residents. On site research suggests a different interpretation. Some inmigration to the Sheridan area has occurred in anticipation of mine employment. These people accept various types of employment while waiting for a job opening at a mine. Thus, when hired, they are categorized as local residents. In fact, they are very recent residents. Being a local requires a period of social integration. This feature is treated more fully in the analysis of social impacts (section III. C. 10.). From a demographic perspective, in-migration in anticipation of mine employment can have the effect of raising population above the projected levels.

8. Land use

a. Present

The area to be fenced by the proposed new mines totals 6,040 acres, and therefore, the impacts on the present dominant land use (grazing) would be slight. As the new mines represent a considerable catalyst for growth, Sheridan and its peripheral area would change from undeveloped open land to intensive urban usage. The approximate conversion factors for each 1,000 persons entering the community would be about 155 acres, provided that existing land-use patterns continue. For the following reasons these figures are only approximations of conversions that would occur (VTN Colorado, 1975b):

1. Existing buildings could absorb some of the expected growth.
2. Vacant lots within developed areas would be used for some new facilities.
3. Current planning activities could change the distribution of developable lands.
4. New development may be more land-intensive than that which has occurred in the past.

Rural areas not subject to stringent land-use controls and land-development regulations may be adversely impacted by scattered development (VTN Colorado, 1975b). This kind of uncontrolled development can adversely affect adjacent land values and community appearance and detract from the orderly development of the community; moreover, in the conversion of agricultural lands to more intensive uses, it is possible that highly productive irrigated lands might be lost.

b. Land-use planning

Land-development plans have been proposed by land-use planning boards in both Rosebud and Big Horn Counties, Montana. The proposed expansion of mining in the Decker area would have little impact on these plans. Adverse secondary impacts from the new mines could result, however, in the event that proposed land-use plans are not adopted or adopted plans are not fully implemented. Uncontrolled, scattered development in agricultural lands for example could decrease adjacent land values, thus, hastening additional land development. Should this happen, net agricultural productivity for these counties could decline.

The adoption of land-use plans for Sheridan County, aside from subdivision regulations, could occur in the near future inasmuch as a comprehensive plan is currently under preparation for the city. Pressures to change county land uses in localized areas as a result of the Decker mine expansions should be reflected in this comprehensive plan, thus moderating or eliminating adverse impacts.

Sheridan, Wyoming, the place of residence for most Decker mine employees, may find community appearance and orderly development to be greatly impacted should more extensive land-use planning not be undertaken. Some of the mine-caused land-use impacts on the city of Sheridan may prove to be beneficial inasmuch as new community services and facilities would be provided and land values would increase.

9. Local economy (Polzin, 1975)

a. Introduction

The economy of the impacted area may be conceptually divided into basic and derivative sectors. Basic industries are those which depend heavily on markets outside the area or are otherwise influenced by factors beyond its borders. Examples of basic industries are agriculture, railroads, the Federal government, and of course, mining. Derivative industries, on the other hand, principally serve the local population and include such business as wholesale and retail trade, services, and local government.

Economists believe that economic growth in small regions, such as the impacted area, can be attributed to events outside the region and that changes in the basic industries lead to further changes in the derivative industries. That is, basic industries sell their products outside the area or otherwise receive their funds from external sources. A significant portion of these "new" dollars are paid directly to workers in basic industries who, in turn, buy goods and services from local merchants. As these dollars are spent and respent within the local economy, they generate additional wages and salaries and may lead to new jobs in the derivative industries. The income expansion does not go on forever; sooner or later these dollars are spent for items not produced in the impacted area and they exit from the local economy.

The proposed Decker mines would create direct employment for miners, railroad employees, and construction workers. As the earnings of these basic workers are spent and respent in the local economy, further derivative jobs would be created. These positions include additional clerks, auto mechanics, school teachers, and other workers in trade and service industries. The new derivative jobs would occur thoughout the local economy and would not be obviously associated with coal development.

The increase in employment is projected to be entirely in Big Horn and Sheridan Counties. Although the proposed mines would be in Montana, a large proportion of the mine-related workers would live in Wyoming and, consequently, most new derivative jobs would be in or near the city of Sheridan.

b. Employment and earnings changes

A summary of the increase in earning and employment attributable to the proposed Decker mines is presented in table 51. These figures represent the net impact of the proposed Decker mines. The projected effects of the decline in agricultural production due to mining activity have been subtracted.

The impact of the East Decker mine would begin in 1976 with the addition of 165 construction workers and the indirect creation of 100 to 140 new derivative jobs. Production is scheduled to begin in 1978. Mine-related employment for this year and 1979 include both construction and operations personnel. In 1980, when the mine is in full production, there would be 297 miners and railroad workers plus 340 to 470 derivative jobs. Basic employment is projected to remain constant to the year 2000 with a small decrease in the number of derivative jobs.

The North Extension mine is projected to employ 125 workers, including 50 site-preparation employees, and 5 railroad employees during 1976 (table 47). In addition, between 140 and 190 new derivative jobs would be created in the local economy. Total earnings of basic and derivative workers would be $2,718,000 (1970 dollars). Beginning in 1977, operations employment at the mine and railroad employees would number 75 workers, and there would be from 100 to 140 derivative jobs. Projections to the year 2000 show basic employment remaining constant and a slight decline in the number of derivative jobs.

Table 51.--Projected increase in earnings and employment, proposed Decker mines, Big Horn County, Montana, and Sheridan County, Wyoming, 1976 to 2000
(Polzin 1975)

	1976	1977	1978	1979	1980	1985	2000
East Decker mine [1]							
Total earnings (thousands of 1970 dollars)	$2,846	$3,810	$6,868	$7,249	$8,013	$9,007	$12,726
Employment							
Total	265-305	345-395	605-725	595-725	637-767	627-767	587-737
Mine-related jobs [2]	165	215	285	275	297	297	297
Derivative jobs	100-140	130-180	320-440	320-450	340-470	330-470	290-440
North Extension mine							
Total earnings (thousands of 1970 dollars) [1]	$2,718	$1,874	$1,919	$1,963	$2,009	$2,261	$3,200
Employment							
total	265-315	175-215	165-205	165-195	155-195	155-195	145-185
Mine-related jobs [1]	125	75	75	75	75	75	75
Derivative jobs	140-190	100-140	90-130	90-120	80-120	80-120	70-110
Total, North Extension and East Decker mines							
Total earnings [1] (thousands of 1970 dollars)	$5,564	$5,684	$8,787	$9,212	$10,022	$11,268	$15,926
Employment							
Total	530-620	520-610	770-930	760-920	792-962	782-962	732-922
Mine-related jobs [2]	290	290	360	350	372	372	372
Derivative jobs	240-330	230-320	410-570	410-570	420-590	410-590	360-550

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[1] Total earnings of mine-related and derivative jobs less the negative impact on agriculture earnings

[2] Includes mine, construction, and railroad employment.

The combined North Extension and East Decker mines are projected to directly and indirectly create 530 to 620 new jobs and $5,564,000 in additional earnings in 1976.

Measured in terms of employment, the maximum impact of these mines is projected for 1980, when there would be between 792 and 962 additional employment opportunities. Total earnings are projected to grow after this date because of the (real) increase in earnings per worker.

The magnitude of the projected impacts may be put in perspective by comparing them to current levels of earnings and employment. During 1972, Big Horn County had total earnings and employment of $33,700,000 (1970 dollars) and 3,742 workers. The corresponding figures for Sheridan County were $47,000,000 (1970 dollars) and 7,856 workers, respectively. The projected increases for both mines in 1976 represents about 7 percent of combined 1976 earnings and from 4.5 to 5.3 percent of combined 1976 employment in the two counties. For just Sheridan County, the corresponding figures are 11.4 percent and 6.7 to 7.9 percent, respectively.

The projections in table 48 suggest few disruptions between the construction and operation phases of the proposed mines. Projected employment would decline by only about 10 jobs between 1978 and 1979. Given the uncertainties and rough nature of the projections, a decrease of this magnitude may be a statistical artifact. The gradual decline in the number of derivative jobs after 1980 should not be viewed with alarm and need not imply that people would suddenly be thrown out of work. These decreases would occur over many years and may be accomodated through normal attrition.

Most attention would undoubtedly be centered on the new mine-related jobs. They would be stable and well-paying positions; the earnings per worker is projected to average between $14,000 and $15,000 (1970 dollars) per year in 1980.

The new derivative jobs--the clerks, shopkeepers, and service personnel-would outnumber mine-related employment by a significant margin. Their average earnings, $7,500 to $10,500 (1970 dollars), would be far below that of the miners and railroad employees. These positions usually require little training and many are part time, making them attractive to women, young people, persons in search of a second job, or others desiring these types of positions.

c. Changes in governmental operating expenses and revenues

The projected changes in government revenues and operating expenditures during 1980 attributable to the proposed Decker mines are presented in table 52. These figures should not be viewed as precise forecasts of the financial situation of the various government units. Instead, they represent only the incremental effects of the proposed Decker mines on government expenditures and revenues. Projected expenditures include only operating expenses for ongoing activities which are financed on a continuing basis. Expenditures for selected new construction are listed in Appendix G (p. G-55 through G-75). Several of the taxes are currently under revision or have recently been changed. All the implications of these modifications are not yet known. The projections are based on preliminary interpretations following discussions with appropriate government personnel. Whenever possible, the most conservative assumptions were used. That is, expenditures were projected high, and revenues were projected low. Therefore, the figures shown in table 52 probably represent the least favorable outcome.

Table 52.--Projected Government Expenditures and Revenues, by Government Unit
North Extension and East Decker Mines
1980

Government Unit	North Extension Mine		East Decker Mine		Total, North Extension and East Decker Mines	
	Expenditures[a]	Revenues	Expenditures[a]	Revenues	Expenditures[a]	Revenues
Montana						
State of Montana	$11,100	$2,394,300	$ 45,900	$13,262,700	$ 57,000	$15,657,000
Big Horn County	2,800	393,200[b]	11,500	2,062,900[b]	14,300	2,456,100[b]
High School District 12 and Elementary District 1	7,700	20,500[b]	31,500	57,500[b]	39,200	78,000[b]
Wyoming						
Sheridan County	$15,700	$ 8,300[c]	$ 64,800	$ 33,700[c]	$ 80,500	$ 42,000[c]
City of Sheridan	34,700	12,200[c]	143,300	49,200[c]	178,000	61,400[c]
School District 2	73,900	51,700[c]	306,900	213,600[c]	380,900	265,300[c]

[a] Excludes new construction.

[b] Does not include intergovernmental transfers.

[c] Includes transfers and tax distributions from the State of Wyoming.

The Montana governments are projected to experience sizeable revenue surpluses. The State of Montana would receive almost $16,000,000 (1970 dollars) during 1980 in combined revenue from the proposed Decker mines. Some of this would return to the local area in the form of intergovernmental transfers and direct spending by the State government. Big Horn County is projected to receive $2,456,000 (1970 dollars), and the revenues of the two impacted school districts would rise by $78,000 (1970 dollars). Local governments in Wyoming, on the other hand, are projected to suffer deficits because of the proposed Decker mines. The increase in operating expenditures exceed the growth in revenue. These deficits, however, are projected to be far less than the surpluses in Montana. At the present time Wyoming has no personal income tax.

In addition to operating expenditures, the Sheridan School District would be required to undertake about $372,000 (1970 dollars) in new construction. The financing of these projects is likely to be a serious problem because the school district currently has a bonded indebtedness of almost 92 percent of its legal bonding capacity. Furthermore, the Sheridan sewage-treatment plant may require modifications totaling $1,800,000 to $2,000,000 (1973 information). These expenditures are not the direct result of the proposed Decker mines, but they would add to the burden placed on Sheridan residents.

10. Social structure and social services (Institute for Social Research, 1975)

a. Introduction

It was very difficult for respondents to the Institute's survey to imagine the impact of development that they had not yet experienced. The existing Decker mine operation seemed to them to represent "desirable development" (payrolls and tax revenues) without "undesirable growth" (crowding and inflated prices). Responses to the survey questionnaire shed some light on the development-growth dilemma and related matters.

There was substantial agreement among respondents that the impact of the 250 or so new families on community services would be detrimental, especially to police protection and schools. More than half of the people also thought that sewage service, hospital services, water-supply system, streets and roads, fire protection, and recreational facilities would be adversely affected by the population influx resulting from expansion of the proposed Decker mines. Moreover, between 41 and 48 percent thought that shopping facilities, medical services, ambulance service, city government, and dental services would be adversely affected. Least affected according to respondents would be mental health services, county government, and services to senior citizens.

Respondents to the Institute's survey felt slightly more strongly about other likely impacts. For example, it was the feeling of 81 percent that the price of housing would go up sharply, of 45 percent that Sheridan would not be a better place to live, of 41 percent that the town would be unable to handle the 1,000 or so new people, and of 57 percent that they would be less safe than they have been. On the other hand, 54 percent thought that there probably would be more jobs, 59 percent believed that local people would still control decisions, and 49 percent anticipated that newcomers would be easily accepted into the community.

As for the main changes in Sheridan during the past three years, 55 percent thought that housing costs had risen most, while 27 percent thought that other living costs had risen most.

Decker Coal Co.'s principal effect on Sheridan has been twofold according to the survey's respondents. Whereas 34 percent said that the company's principal effect on the town has been economically beneficial, 37 percent said that its principal effect has been to increase rents and living costs. Overall, however, people in Sheridan have a positive feeling toward Decker Coal Co., and 52 percent would definitely not oppose the proposed mine expansion. Others (35 percent) would like more information about these plans and the probable consequences before making up their minds on the expansion question.

In general, respondents felt that it was somewhat difficult for them to separate Decker's past or future social impact from that of other coal companies. Moreover, the respondents had so much difficulty imagining what an increase of a thousand or so people would be like that it probably would not have made any significant difference in their responses if they had been asked about the increase in terms of 1,500 to 2,000 new people.

b. The people

(1) The employed

Most of the respondents said expansion would have no effect on their own jobs, but that more jobs would be available in Sheridan, where job opportunities had not been good. Mine expansion would likely increase competition for available labor, and the existing low-income labor pool would become smaller.

(2) The elderly

The impact of the more highly paid miners on the costs of goods and services to those on fixed incomes would be serious. Senior citizens would be at a disadvantage in the competition for housing, and those who rent might have to look to the city and county for assistance with housing.

Another area of impact would be a change in the character of Sheridan. It is now in the early stages of changing from a haven for retired ranchers and farmers to a place where it will be increasingly difficult for older people to enjoy the controlled, relaxed, and rural-service-town atmosphere. This had been its main attraction before the town's recent growth cycle began. Sheridan would become bigger, more urbanized, more impersonal, and more expensive; retired people would tend to settle elsewhere; and natural attrition would further reduce the number of Sheridan's senior citizens.

(3) Miners

Miners in the survey were the strongest supporters of expansion of the Decker Coal Co. operations. Seventy percent of the miners in the survey agreed that there would be more jobs available in Sheridan and that Sheridan could handle the impact. They reported more concern about housing availability and less concern about rising costs than did the rest of those surveyed.

(4) Other Sheridan residents

To date, coal-related development has been sufficiently extensive to help local businessmen, but not so exclusive as to attract more chain stores and discount centers. Some small family businessmen were fearful that increasing coal development would bring unwanted competition, but other young businessmen saw potential opportunities for moving up to newly created managerial positions. Respondents in blue collar and clerical jobs supported expansion of the mine operations more strongly than "professionals" did, but about the same as the average person in the survey.

(5) Montana ranchers living near the proposed Decker Mines

Although the coal issue has sharply divided some areas, some ranchers are making a real effort to keep alive the old social relationships, i.e., the old neighboring and helping patterns. Those people feel that these personal relationships, which have been nurtured in the past, have kept the communities together in hard times. One individual said that in previous times of crisis her community had always drawn closer together, thus gaining strength to meet the challenge. Now, she said, the coal issue is tearing the community asunder.

The old practice of "that's his business" that once was part of the Golden Rule in this area and the attitude of "I'll go it alone" had a survival value in the past, but just like some biological adaptations and overspecializations, these attitudes may cause the species to become extinct. Some are now saying that they believe neighbors should tell each other if they are going to lease and the exact terms of the lease. A couple of persons interviewed said that when others lease to coal companies, it is a good indication of how they feel, meaning that they are showing that they are for coal development because they have leased their land. Few of the residents demonstrated that they were aware that people's attitudes toward something and their behavior concerning it could be quite different.

One man said that the coal issue is making people reassess what they want out of life. Now they can actually choose whether they want to (1) sell out, retire, and know they can afford a good retirement; (2) trade for a much larger ranch; or (3) move to another area.

Many ranchers have said that if they could make a good enough deal and get a much better and larger ranch than they now have, there would be no question that they would uproot and move to a new place. The economics of the situation would facilitate severing any social ties they might have to their old community.

A lawyer representing some ranchers in the study area who are thinking of selling said that many go away thinking twice about selling when he confronted them with the problems of running more cattle and the possibility that they might have to depend on more help at a time when it is almost impossible to hire a good hand.

c. Quality of life and social values

Respondents to the Institute's questionnaire talked about what the proposed expansion of the Decker mine operation would do to or for Sheridan, its way of life, and its social structure in words like these:

> "It is hard for us to grasp the likelihood of great change here. Some of the business interests would welcome it, but most of us really don't welcome it, even though we feel we should go along with it."
>
> "What if we become another Gillette or Rock Springs? Does the country really need the energy that badly?"
>
> "No matter what happens, Sheridan will cope. Sheridan has always risen to the occasion. We will cope if we have to."
>
> "Our enjoyment of life will be negatively affected by more people and more traffic and not knowing the people you meet on the street."
>
> "Will the locals still control things? I hope so."
>
> "More liberals and colored people will come in."

> "If we just had to contend with new people, fine, but we'll have to contend with industry. I have in mind that other companies will be moving here, too."
>
> "Sheridan can't get any better."
>
> "I can't see that the town would change that much. I've been in boom towns and generally there was no long-lasting effect."

d. Social services and public facilities

(1) Housing

Virtually no rentals or moderately priced houses are available at this time, and little construction is underway. The addition of any work force to the area, therefore, would put a severe strain on the housing situation that most residents are already describing as "terrible."

Mobile-home parks are now under construction, and there is some remodeling and new building; however, all of that is needed to ease only the existing pressure for housing. Table 53 indicates a need for 476 new housing units in Sheridan County if the two Decker mine proposals are implemented.

Most residents interviewed said that they expect the price of housing to go up sharply if expansion of mine operations is approved; and, as indicated in table 54, many expect that the biggest change in Sheridan from the proposed mine expansions would be increased housing costs or decreased housing availability.

Calling attention to the housing impact, an employment officer said, "We could provide most of the construction force for expansion, except for housing." Among those who thought Sheridan could handle the number of people that would come with mine expansion, many qualified their assurance

Table 53.--Housing demands in Sheridan County of new Decker Coal Co. and full-time derived employees[1]
(Institute for Social Research, 1975)

	1976	1977	1978	1979	1980 2000
If only the East Decker mine opens:					
Number of new employees	265	345	605	595	637
Number of housing units needed in Sheridan County	238	310	544	535	573
If only the North Extension mine opens:					
Number of new employees	265	175	165	165	155
Number of housing units needed in Sheridan County	238	157	148	148	139
If both mines open:					
Number of new employees	530	520	770	760	792
Number of housing units needed in Sheridan County	476	467	692	683	712

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[1] Assumes that 90 percent of the employees will live in Sheridan County and that each employee will generate a demand for one housing unit.

Table 54.--Relation of anticipated effects of population influx to years of residence in Sheridan County (Institute for Social Research, 1975)

If 250 new families (at least 1,000 people) move into Sheridan in the next two years, which of the following items would be most affected? (select one)	Years of residence in Sheridan County					
	less than 1 year	more than 1, less than 3 years	3 but less than 5 years	5-10 years	most or all of life	Total
	(Percent of respondents)					
Housing costs	0.8	0.8	2.5	0	17.5	21.7
Other living costs	0	.8	0	1.7	5.8	8.3
Employment opportunities	0	0	.8	.8	5.0	6.7
Recreational opportunities	0	0	0	0	.8	.8
Community services (e.g., schools, police)	0	1.7	0	5.0	3.3	10.0
Relationships between groups of people	.8	0	0	0	1.7	2.5
Housing availability	4.2	1.7	6.7	4.2	30.8	47.5
Health-related services	0	0	0	0	0	0
Declined to respond	0	0	0	0	2.5	2.5
Total	5.8	5.0	10.0	11.7	67.5	100.0

with "except for housing." In all likelihood more mobile-home parks must be constructed to provide housing if the proposed mine expansion is approved. Because the location of these parks probably would not be dictated by the availability of classroom space in schools, irritations already caused by busing students out of their neighborhoods would become more acute. As pressures grow for more school funds, residents who own single-family homes probably would feel that they are carrying an unfair tax burden because trailer owners would be paying lower property taxes. In all probability, the traditions of most people owning their single-family homes would further conflict with those of trailer residents, many of whom would harbor resentments of their own for not being given the opportunity to live in single-family homes.

The impact on fixed-income and low-income residents would increase sharply as no subsidized or other low-income housing is planned for construction in the near future. The cost of housing would probably make Sheridan an unlikely place for retirement, except for the well-to-do.

Not all of the increased housing costs and decreased housing availability would be caused by approval of the Decker Coal Co. proposals. The effects of other coal-related developments in the Lake DeSmet and Gillette areas are not so concentrated or obvious, and the impact from other proposed developments closer to Sheridan would come after the proposed Decker mine expansion had borne the heavy burden of occurring first. Moreover, these other Wyoming developments would be considered more desirable because all tax revenues would accrue to Wyoming.

(2) Water and sewage

The additional population may not overload the total capacity of either the water-treatment or sewage-treatment plant, depending on the distribution of new arrivals in Sheridan County. However, water-distribution lines and sewage-collection lines are already inadequate in some sections of Sheridan.

A study of Sheridan's water and sewage system should provide accurate information on the present loading and potential capacity of the distribution and collection system (Black and Veatch Consulting Engineers, 1974).

(3) Transportation

Respondents said that streets and roads already need improvement and would be adversely affected by the proposed mine expansion. No matter where the additional workers live, the road between Decker and Sheridan would receive the greatest impact of increased travel. As more people turn to Billings, Montana, for service, I-90 to Billings would also be more heavily traveled.

(4) Schools

Using the population projections developed in this report, it is possible to make predictions of the impact the incoming school age population would have on School District No. 2 (Sheridan) where, it is assumed, all incoming school age children would live. Table 55 gives the number of school age children in Sheridan and Big Horn Counties. If the proposals are implemented, School District No. 2 would have to provide room for approximately 290 new students during the first school year thereafter. It

Table 55.--Projected school age population increase and resulting need for additional classrooms/teachers at maximum capacity and to meet adequacy standards for new students - Sheridan and Big Horn Counties (Institute for Social Research, 1975)

	1976	1977	1978	1979	1980	After 1980
Sheridan County						
1. If both mines open:						
a. Total additional school age population	286	282	471	483	504	504
b. Classrooms/teachers needed at maximum capacity[1]	11	11	19	19	20	20
c. Classrooms/teachers needed to meet adequacy standards[2]	16	15	26	27	27	27
2. If only the North Extension mine opens:						
a. Total additional school age population	154	110	104	104	98	98
b. Classrooms/teachers needed at maximum capacity	6	4	4	4	4	4
c. Classrooms/teachers needed to meet adequacy standards	9	6	6	6	5	5
3. If only the East Decker mine opens:						
a. Total additional school age population	132	172	367	379	406	406
b. Classrooms/teachers needed at maximum capacity	5	7	15	15	16	16
c. Classrooms/teachers needed to meet adequacy standards	7	9	20	21	22	22
Big Horn County						
Total additional school age population if both mines open	32	31	53	54	56	56
Classrooms/teachers needed at maximum capacity	1	1	2	2	2	2
Classrooms/teachers needed to meet adequacy standards	2	2	3	3	3	3

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[1] Maximum acceptable capacity per classroom of 27 students.

[2] 18.2 children per teacher (source: Intermountain planners and Wirth-Berger Associates, 1974, p. 35).

is extremely unlikely that the homes of the incoming elementary school children would match the approximately 150 existing vacant spaces, and therefore, some classrooms would be crowded.

Maximum acceptable classroom capacity in Sheridan is listed as 27 for grade schools and 25 for high schools. Using the standard of 18.2 children per teacher (Intermountain Planners and Wirth-Berger Assoc., 1974, p.35), the Sheridan schools are inadequate. For example, applying this adequacy standard to the District No. 2 enrollment for the school year 1974-1975 (table 56), the district needs a total of 35 additional teachers. If both proposed Decker mine expansions are approved, the district would require an additional sixteen teachers during the 1976-1977 school year.

If the district does nothing during the next two years, it might be able to accommodate students in overcrowded conditions. However, in the years thereafter, additional facilities would be mandatory. People in Sheridan already expect that Decker Coal Co.'s proposed operations would cost them more to support the schools and that, in the words of one respondent, "those who live in mobile homes that are not taxed as high as other residences will not pay as much for school expansion as old timers."

When asked how the influx of 250 families during the next two years would affect the grade schools and the high school, most of those surveyed in Sheridan indicated that the influx would be detrimental to the schools.

It is not possible to accurately predict the impact of the projected influx on the quality of education in School District No. 2, although it is reasonable to expect a strong reaction to the degradation of a community service with which the residents are currently satisfied. It is also reasonable to expect increased dissatisfaction as more students are bused to equalize school enrollment.

Table 56.--Additional teachers and classrooms needed to meet adequacy standards[1/] during school year 1975-76, School District No. 2, Sheridan, Wyoming (Institute for Social Research, 1975)

School [2/]	Grades	Number of existing teaching stations	Number of classroom teachers	1974-1975 enrollment	Additional teachers and classrooms needed to meet adequacy Standards
Coffeen	K-6	19	19	411	3
Highland Park	K-6	13	13	373	7
Linden	K-6	13	13	352	6
Taylor	K-6	7	7	165	1
Woodland Park	K-6	7	7	198	4
	7-8	4	4	65	-
Central School	7-8	18	18	456	7
High School	9-12	44	56	1,137	7[3/]
Total number of additional teachers required to meet adequacy standards					35

[1/] 18.2 students per teacher (Intermountain Planners and Wirth-Berger assoc., 1974, p 35).

[2/] Acme, Beckton, and Story schools are not included because they have more than one grade in a classroom.

[3/] Indicates only the number of additional teachers required to meet the standard of 18.2 students per teacher.

(5) Recreation

The population influx would place increased demand on recreational facilities. The residents of Sheridan, who are accustomed to uncrowded outdoor recreational facilities, expect to feel the greatest impact. For example, many respondents expressed concern that outdoor recreation would become too crowded and hunting unsafe. They pointed out that much private land is already being posted. People who are indoor recreationists account for the finding that 49 percent of Sheridanites anticipated that the proposed mine expansion would have no effect on recreational opportunities.

(6) Public safety

The population influx associated with the two proposed mines would place additional strain on an already understaffed police department. If both proposals are approved and if existing shortages are corrected, 14 additional officers, new equipment, and expanded police facilities would be needed. Most of the survey respondents indicated that the influx of at least 1,000 people would make it harder to provide adequate police protection, but that their feelings of safety would depend largely on what kinds of people move into the Sheridan area.

If the population increase stimulates building or adds mobile homes in an area with inadequate water lines, the fire protection in these areas may become critically inadequate. Assuming that many new mobile homes would be located outside the city limits, a great strain would be put on fire protection facilities at the airport. When the City Engineer's study of existing water mains is completed, the city should have sufficient information to judge the impact of new construction.

(7) Social and welfare services

The population influx would aggravate the already serious problem of welfare recipients. According to welfare department officials, new workers are already outbidding welfare recipients for the small number of available houses.

(8) Health services

The existing health-care personnel and facilities should be adequate to take care of the population increase associated with the proposed Decker mine expansion. However, if surrounding counties, which also use the Sheridan hospital, experience substantial population increases without corresponding increases in health-care facilities, the Sheridan hospital would be inadequate to handle the demand. The hospital's capacity, not the number of health-care personnel, is at present the main limiting factor in determining health-care adequacy in Sheridan County.

If the Decker Coal Co. maintains an ambulance for its employees at the mine site, the existing ambulance service in Sheridan should be adequate for the increased demand.

11. Archaeological and historical sites

Cumulative impacts to archaeological sites identified at the proposed East Decker and North Extension sites should be no greater than the arithemetic sum of the individual impacts in each area detailed in sections III. A. 7. and III. B. 7. None of the sites discovered in either area are currently listed in the National Register of Historic Places; one site in the East Decker area, however, has been recommended for testing to determine its eligibility for inclusion in the National Register.

All but one of the 14 sites in the East Decker and North Extension areas identified by Fredlund (1976) have been properly recorded and evaluated. All important artifacts have been salvaged and preserved. The disturbance of such sites by mining, therefore, should have minimal impact on man's understanding of the cultural resources in the Decker area. The other site identified by Fredlund (1976) requires subsurface examination before the presence or absence of buried material can be confirmed. Accordingly, disturbance of this site prior to testing could result in the permanent loss of archaeological resources.

All eight of the North Extension and East Decker sites identified by Lahren require appropriate archaeological study and recovery of artifacts to assess their value as cultural resources. Accordingly, any disturbance of these sites prior to an adequate appraisal could result in a serious archaeological impact.

No structures or ruins within the East Decker or North Extension project areas are listed in the National Register of Historic Places, nor has any structure or ruin within these areas been so nominated. One set of old structures adjacent to the East Decker mine area has not been adequately photographed and evaluated. Destruction of this site prior to an appropriate evaluation could constitute a minor impact.

12. Recreation facilities and activities in the Decker area

Fencing of the East Decker and North Extension mine areas in addition to the area already fenced at the existing West Decker mine would result in the loss of approximately 9,000 acres of potential recreation area in the Decker vicinity. Adjacent lands may be subjected to slightly greater utilization pressures as a result of this decline in available land area.

The cumulative recreational impacts on lands adjacent to the three mines would result in far greater landscape disturbance than that stemming from any one of the three operations.

Other cumulative recreation impacts from the three mine areas are also additive and include: (1) increased demand for and possible overuse of the existing Tongue River recreation facilities (see p. 377 and 432), (2) possible pollution and littering problems on acreages adjacent to the mine area, (3) possible human interaction problems at congested existing recreation facilities, (4) deterioration in the recreational aesthetic values of the Tongue River Reservoir and recreation area from the disruption of scenic views, increased ambient noise levels, and periodic dust clouds, and (5) an impact on hunting caused by increased poaching and wildlife-vehicle collisions.

Despite the proposed expansion of mining activities into the East Decker and North Extension areas, the Tongue River Reservoir should continue to be used by boaters, water skiiers, fishermen, hunters, and other recreationists. Because of normal reservoir drawdown during the late summer, recreational use of the reservoir would continue to be concentrated largely to the area north of the proposed East Decker and North Extension mines.

A summary of cumulative mine-related impacts that could affect the utility of the reservoir as a recreation area is as follows:

1. Interruption of ground-water and surface-water flow by the concurrent operation of the two mines should have no significant adverse impact on the volume of water or the water level of the Tongue River Reservoir.

2. The greatest impact to the quality of water in the reservoir should occur during mining rather than after reclamation. Cumulative effects on water quality both during and after mining, however, would be so small as to have virtually no detrimental effect on the use of the reservoir or its water.
3. The concurrent introduction of nitrate from blasting into mine effluents probably would not be detectable after mixing with reservoir waters because of the extreme dilution that would occur.
4. By using appropriate mitigating measures, sediment yield to the reservoir might be reduced as much as 50 percent (18-25 acre-feet annually) during mining. Thereafter, sediment yield to the reservoir probably would be reduced by at least 25 percent (10-20 acre-feet annually).
5. A possible decline in hunting pressure on water fowl utilizing the Tongue River Reservoir could occur inasmuch as mine-safety requirements do not allow hunting within mine areas. Removal of seasonal stubble fields utilized as feeding areas for Canada geese would occur should the North Extension mine be approved.
6. The fisheries of the Tongue River Reservoir could be negatively impacted if mining at any or all of the three mine sites caused substantial changes in reservoir water quality and sediment load. Increased sodium or other chemical levels in the reservoir could occur from the leaching of mine spoils or from mine-water discharge into the reservoir, but are not expected. If a substantial (and hence unmitigated) increase in reservoir sedimentation were to occur, fish productivity could decline.

7. Loss of vegetation and wildlife, land-form degradation, periodic blasting, and the presence of spoil banks, loading equipment, railroad spurs, buildings, and coal-processing equipment would detract from the aesthetic quality of the area as perceived by reservoir users. General increases in human activity on the reservoir also would add to aesthetic degradation.

13. Aesthetics

Cumulative aesthetic impacts represent the sum of those attributable to the proposed mines and the existing West Decker mining operations. Loss of vegetation and wildlife, landform degradation, periodic blasting, and the presence of spoil banks, loading equipment, railroad spurs, buildings, and coal-processing equipment would detract from the aesthetic qualities of the area. This may be especially true for people using the Tongue River Reservoir for recreation purposes (see sections III. A. 9. and III. B. 9.). Potentially, the loss of air quality and any increases in ambient noise levels would severely impact the sense of peace and tranquility that presently characterize the area. General increases in human activity and demands brought about by this increased population could potentially impact the aesthetic environment well beyond the proposed mine boundaries. It is impossible, however, to determine the severity of this impact at present (VTN Colorado, 1975b).

14. Removal of the coal

The two proposed mines would remove about 180 million tons of sub-bituminous low sulfur coal, an action that would result in the permanent depletion of this fossil-fuel resource. All coal within the proposed mine areas that can be recovered economically by surface methods would be removed. Those deeply buried coal beds and the remaining parts of the shallower coal beds that extend below the depth where they currently can be mined by surface methods would be left essentially undisturbed for possible future development by surface, underground, or *in situ* methods.

15. Train traffic and other long-distance transportation of the coal

Coal from the proposed East Decker and North Extension mines would be transported directly by unit trains (100 cars, each carrying 100 tons) to utility companies in Illinois and Texas or to terminal facilities in Wisconsin and Illinois where the coal would be loaded on boats or barges and shipped to electric power generation plants in the Detroit and Chicago areas (p. 78). Cumulative impacts from this increased rail traffic generally are as follows:

1. Periodic obstruction of at-grade road crossings and consequent delay of vehicular traffic, including emergency vehicles, school buses, mail-delivery vehicles, and general farm-to-market traffic.
2. Increased hazard of train-vehicle and train-livestock collisions where crossings are at-grade and are not adequately protected. Roads in rural areas are commonly used as livestock driveways en route from one pasture to another.
3. Increased frequency of noise pollution.
4. Increased windblown and accidental spillages of coal.
5. Increased gaseous emissions and consequent air pollution along the railroad right-of-way and adjacent areas.

6. Increased losses of livestock and wildlife in those areas where existing fences are substandard or where maintenance is inadequate.

7. Increased hazard of railroad caused fires.

8. Increased track and equipment maintenance costs.

Two at-grade road crossings on the Decker spur line would be subject to increased train traffic and, thus, increased cumulative impacts from simultaneous operation of the two proposed mines and the existing West Decker mine. They are the crossing on Route FAS 314 about 1.5 miles south of the West Decker plant area (p. 437 and fig. 10) and the crossing on Wyoming State Highway 336 about 15 miles south of the Decker area and about 3 miles northwest of Wyarno, Wyoming. The Wyarno crossing is complicated by the fact that the south-trending Decker spur line divides to form a "Y" before joining the east-trending main line of the Burlington Northern Railroad. Highway 336, which lies north of and parallels the main line, crosses both arms of the "Y". The Wyarno crossing, therefore, is actually a double railroad crossing with eastern-bound traffic routed on the easternmost track and western-bound traffic toward Sheridan routed on the westernmost track.

No additional impacts would occur at the county road crossing on the East Decker spur line, which would carry only train traffic from the East Decker mine. Impacts associated with that crossing are discussed on page 380.

Unit coal trains per week passing the above road crossings and the approximate minutes per day that these crossings would be blocked to traffic are shown in the following table.

Road crossings	Unit trains per week past crossing[1]				
	From East Decker mine	From North Extension mine	From West Decker mine	From all 3 mines	Minutes per day crossings would be blocked by trains[2]
County road	25.8	--	--	25.8	20
Route FAS 314	--	8.8	38.4	47.2	37
Wyoming Highway 336 near Wyarno	25.8	8.8	38.4	73.0	57

[1] Includes loaded outgoing and empty returning trains.

[2] According to Burlington Northern observations, loaded trains would block crossings an average of about seven minutes; empty trains would block crossings an average of about four minutes.

All production from the North Extension mine, about 2.3 million tons per year, would be transported by unit train on the Burlington Northern main line through Montana, North Dakota, and Minnesota to Superior, Wisconsin. There it would be loaded on boats at the recently completed $45 million Superior Midwest Energy Terminal and shipped via the Great Lakes to the Detroit area. This facility was designed and constructed for transshipment of coal from the Decker area and incorporates the latest technological advances to minimize impacts on the environment. Train traffic to and from Superior, Wisconsin from the North Extension mine would average about nine trains per week. Impacts identified on p. 499 would be increased accordingly. At-grade crossings en route would be blocked an average of about seven minutes additionally each 24-hour period by these trains.

About four million tons of coal annually from the East Decker mine would be transported to Commonwealth Edison plants in Illinois over the

Burlington Northern main line through Wyoming, Nebraska, Iowa, and Illinois. Approximately half this tonnage would be transported directly to power generation plants in the Chicago area by unit trains. The remaining coal--about two million tons per year--would be loaded on barges at existing transshipment facilities at Havana, Illinois. The barges, in turn, would carry the coal up the Illinois River to plants in the Chicago area that are not accessible or only difficultly accessible by rail traffic. Coal-train traffic on Burlington Northern lines from the Decker area to Havana would average about 15.4 unit trains per week, including both loaded and empty trains. Train traffic from the Decker area on lines east of Havana would average only about 7.7 unit trains per week. At-grade crossings west of Havana would be blocked about 12 minutes additionally during each 24-hour period by these trains. Road crossings east of Havana would be blocked additionally only half as long. An average of about 5,500 tons of coal per day from the East Decker mine would be transported from Havana to plants in the Chicago area by barge.

About 2.7 million tons of coal annually would be transported by unit trains from the East Decker mine to the power generation plant near Austin, Texas. The exact rail route has not been established, but presumably, most trains would move via the most direct track. Train traffic would average about 10.4 trains per week, including both loaded and empty trains. At-grade crossings en route would be blocked by these trains an average of about eight minutes additionally each 24-hour period.

The cumulative impacts from increased train traffic as a result of simultaneous operation of the three Decker mines, although significant, may be dwarfed over the next decade by increased train traffic as a result of production from other proposed surface coal mines in the area. Proposed or estimated annual coal production and unit trains from mines that might impact the Decker spur line are given in the following table.

Mine	Proposed or estimated annual coal production (million tons)	Unit trains per week past crossing[1]		
		County road	Route FAS 314	Wyoming Highway 336 near Wyarno
West Decker	10	--	38.4	38.4
East Decker	6.7	25.8	--	25.8
North Extension	2.3	--	8.8	8.8
Spring Creek (P.P. & L. Co.)	10	--	38.4	38.4
CX (Consolidation Coal Co.)	3	--	--	11.5
Whitney (Peter Kiewit Sons Co.)	1.5	--	--	5.8
Youngs Creek (Shell Oil Co.)	16	--	--	61.5
Pearl area (Shell Oil Co.)	2	--	--	7.7
Ash Creek (P.S.O. Co.)	.5	--	--	1.9
Total	52.0	25.8	85.6	199.8

[1] Includes loaded outgoing and empty returning trains.

Thus, estimated additional coal production from other mines that probably would use the Decker spur line to transport the coal would have no additional impact on the county road crossing near the East Decker mine. Unit trains crossing Route FAS 314, however, would increase to about 86 trains per week. The crossing would be blocked about 1 hour, 8 minutes during each 24-hour period. Other impacts would increase proportionately. Unit trains crossing Wyoming State Highway 335 near Wyarno would increase to about 200 trains per week (28.6 trains per day). The double crossing would be blocked about 2 hours, 37 minutes during each 24-hour period and possibly much longer in the event of equipment breakdowns or accidents. Other impacts would be increased proportionately.

16. Marketing and consumption of the coal

Coal from the proposed Decker mines, if used for power generation in the Detroit and Chicago areas would displace coal from the Appalachian area. With the rising demand for coal, however, any displacement in the market should be very temporary and should not represent a permanent loss of sales for Appalachian coal.

In the Austin, Texas, area, coal from the proposed Decker mines would be used for power generation in a new plant to be built between LaGrange and Fayetteville, Texas. This would reduce the use of natural gas for power generation and would permit diversion of the gas to other uses.

Continued use of coal from the proposed Decker mines at power plants in Michigan and Illinois would keep sulfur dioxide (SO_2) emissions at permissable levels established by EPA and provide a continued significant contribution to the improvement in local air quality. In Texas where the coal would replace the use of natural gas for power generation, SO_2 emissions and particulate matter would probably increase because coal is not as clean burning a fuel as natural gas. Emissions, however, would not exceed limits established by EPA. Any reduction in the air quality must be balanced against the benefits obtained from other better uses of natural gas.

17. Other mineral resources

No oil or gas production currently exists in the Decker area, and no petroleum resources are known to underlie the area. Moreover, the proposed surface mining of coal would not adversely affect future oil operations in this area.

The North Extension area and to a lesser extent the East Decker area are underlain to a depth of as much as 135 feet by clinker that can be used as a construction material. The quality of the clinker differs widely over short distances, however, and only the more durable grades can be used for surfacing roads and for most construction purposes. The clinker in the mine areas would be mixed with interburden spoil materials comprised largely of shale, siltstone, and sandstone as a result of mining and no longer would be usable as a construction material. Millions of tons of clinker would be spoiled in this manner and lost to subsequent use in the two proposed mine areas. Similarly, small amounts of sand and gravel, primarily in the East Decker area, would be mixed with other material and lost to subsequent use.

Because of hauling costs, construction materials are generally used only in the immediate area in which they occur. The small demand for clinker in this general area coupled with the vast resources of like materials in surrounding areas tends to minimize the importance of this impact.

18. Contribution to relief of the energy crisis

Low-sulfur coal is rapidly increasing in importance as a fuel for electric-power generation in this country. In 1974, about 388 million tons of coal were consumed for electric-power generation in the United States (Coal Mining and Processing, 1975, p. 18). Decreasing domestic supplies of petroleum and natural gas and the increasing cost of imported petroleum have increased the demand for coal as an alternate energy source. The Federal Energy Administration has ordered the conversion by 1980 of many power plants from the use of petroleum to the use of coal. Accordingly, the National Electric Reliability Council estimates that coal consumption for power generation in 1984 will be 780.8 million tons (Coal Mining and Processing, 1975, p. 18). This estimate is based on the number of plants now planned or under construction.

The indiscriminate use of coal as an alternate energy source, however, is controlled by the Clean Air Act, which authorizes the Environmental Protection Agency to set ambient air-quality standards that limit sulfur oxides and other air pollutants that are dangerous to health. To comply with the Act, each state must set and enforce standards equal to or exceeding Federal standards by mid-1975.

Commonwealth Edison of Chicago, Illinois, currently uses coal from the West Decker mine. They have contracted to receive 6.6 million tons annually for the period 1976 through 1978; beginning in 1978, they have contracted to receive an additional 4 million tons per year from the East Decker mine for a period of 20 years. Low-sulfur coal from the Decker area is currently used at the company's Fish, Crawford, Will County, Joliet, and State Line stations, all of which are operating in compliance with EPA and state or local ambient air-quality standards. Those standards could not be met using high-sulfur Eastern coals. If coal from the proposed Decker mines is not made available for future use in these plants, Commonwealth Edison's management doubts that low-sulfur coal with sufficient Btu content from other sources would be available to them.

Commonwealth Edison serves approximately 8 million people in an area of about 11,525 square miles in Illinois. As of November 30, 1975, the company supplied electricity to 2,523,171 residential, 799 large commercial and industrial, 220,394 small commercial and industrial, and 10,626 government and municipal customers.

Detroit Edison serves about 5 million people living in an area of about 7,600 square miles in southeastern Michigan. Company personnel estimate on the basis of existing contracts that coal from the proposed Decker mines would supply 30 percent of their total fuel requirements by 1982. Because of the large tonnages involved, they sincerely doubt that an alternate supply of coal of suitable sulfur and Btu content could be developed within permissible time constraints.

The coal would be used primarily at Detroit Edison's St. Clair and new Belle River power-generation plants and would enable these plants to meet existing and future more stringent ambient air-quality standards. Detroit Edison currently (January 1976) serves 1,538,251 residential, 117,132 commercial, 1,923 industrial, and 1,545 government and municipal customers. Industries within the service area manufacture or produce a large variety of products. Among the more important are automobiles and other transportation equipment; steel, iron, and other metals; chemicals; and machinery.

The Lower Colorado River Authority (LCRA) generates and distributes electric power over a 41,000-square-mile area in central Texas. The service area contains a population of about 1 million people. LCRA distributes power to 30 municipal distribution systems and to 11 rural electrical cooperatives in addition to industrial customers, oil-pumping stations, and similar facilities. Over 90 percent of the power currently generated by LCRA is from plants fired with natural gas; the remainder is generated by hydroelectric power. LCRA and the City of Austin, Texas, are jointly constructing the first unit of a planned 3,000-megawatt station about 65 miles southeast of Austin. This first unit has been designed to use coal from the proposed Decker mines and is scheduled to begin operation early in 1979. Coal from other sources could not be used without major modification of the unit. Moreover, LCRA currently has no other source of coal for the plant. The unit has been designed to meet or exceed EPA and State ambient air-quality standards using coal from the proposed Decker mines. Permits to operate this first unit have been obtained from the Texas Air Quality Control Board.

IV. MITIGATING OR COMPENSATING MEASURES

Environmental impact statements prepared in conjunction with resource development-oriented projects such as the proposed Decker mines provide the means of utilizing the physical, biological, and social sciences in agency decision-making processes. The chapter on mitigations is especially important in that it describes those actions that can be taken to eliminate or reduce the identified impacts that would occur if the proposals are implemented.

The task force recognizes three basic types of mitigating measures relative to the Decker Coal Co. proposals. They are: (1) Measures required by State or Federal laws, regulations, or executive orders; (2) measures proposed by the Decker Coal Co. as part of their mining and reclamation plans; and (3) other measures generally thought to have merit by the task force. The first two categories include those measures that are binding upon the Decker Coal Co. and must be implemented upon approval of the proposals and issuance of a mining permit. By attachment of stipulations, other measures comprising the third category may be required as part of the company's reclamation plans in those instances where the Montana Department of State Lands or U.S. Geological Survey have the statutory authority to do so. Inclusion of these other possible measures in the environmental impact statement affords a practical means of utilizing the expertise of task force members to identify additional measures that, if implemented, would further reduce adverse impacts of the proposals. Inclusion of these other mitigating measures in this statement in no way obligates the Decker Coal Co. or restricts the decision-making prerogatives of the Federal and State regulatory agencies.

It also should be noted that issuance of a mining permit does not convey the right to mine under the terms of that permit over the proposed life of a project. The permit issued by the Montana Department of State Lands must be renewed annually, at which time permit conditions or stipulations may be revised or added as necessary to assure full compliance with laws and regulations, latest techniques of mine-land reclamation, and local experience in achieving reclamation success. Similarly, the Area Mining Supervisor of the U.S. Geological Survey has the authority to require revision of mining and reclamation plans whenever modifications are deemed necessary to correct apparent deficiencies or to more fully comply with existing or newly adopted rules and regulations.

A. Laws and regulations

1. General statement

The two proposed mining operations must comply with all applicable regulations of Federal, State, and County agencies including:

U.S. Geological Survey
Bureau of Land Management
U.S. Environmental Protection Agency
Montana Department of State Lands
Montana Department of Health and Environmental Sciences
Montana Highway Commission
Big Horn County, Montana

Regulations enforced by the above agencies are variously designed to assure realization of the full and best interests of the public, to adequately protect the environment, and to achieve continuing highest productive use of the land consistent with surrounding land uses and management objectives.

2. Federal laws and regulations

Significant Federal laws and regulations for mitigating impacts include:

1. The Mineral Leasing Act of February 25, 1920, which authorizes the Secretary of Interior, through the Bureau of Land Management, to grant coal leases (30 U.S.C.A. 201). The lessee is given the exclusive right to extract and market coal from leased lands under terms set forth in a lease and to use as much of the surface as is reasonably necessary to conduct operations. The lessee, in turn, is obligated under the Act to (1) report quarterly the amount, character, and quality of coal extracted from the leasehold and the selling price per ton; (2) pay royalties quarterly at the rate specified in the lease; and (3) pay annual rental fees at the rate specified. The mining operator is also required (30 U.S.C. 211-214) to file a plan to control soil erosion and to prevent damage to other surface values.

   Regulations setting forth the general and basic policies are found in 43 C.F.R. 1725. Additional regulations governing the issuance of Federal coal leases, permits, and licenses are found in 43 C.F.R. 3500. Regulations governing the environment and safety are found in 43 C.F.R. 3000, including the requirements for surface management of Federal coal resources in 43 C.F.R. 3041.

2. The Taylor Grazing Act of 1934, as amended (48 Stat. 1269), provides the basic legislative authority governing the management and protection of public lands. The Secretary of the Interior is directed to "do any and all things necessary to ***preserve the land and its resources from destruction or unnecessary injury."

3. The Federal Water Pollution Control Act (62 Stat. 1155), as amended by Public Law 92-500 (86 Stat. 816), U.S. Code 33 provides that the U.S. Environmental Protection Agency (EPA), in cooperation with State and other local control agencies, "***prepare or develop comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters ***" and "***to preserve such waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses." The act stresses that "it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited." The EPA has the responsibility for preparing standards for such pollutants as well as for aiding in enforcing adherence to such standards. This act also requires that the EPA administrator set and enforce interstate water-quality standards.
4. The Federal Water-Quality Improvement Act of 1970 (84 Stat. 91) requires Federal agencies to comply with State water-quality standards.
5. The Multiple Use and Sustained Yield Act of 1964 requires that the Secretary of the Interior develop and administer resources for multiple use and sustained yield. Federal Regulations 43 C.F.R. 4122.1 require that all use and management practices, including grazing and the issuance of grazing

leases, be in conformance with the concepts of multiple use and sustained yield.

6. The Endangered Species Act (PL 93-205) provides protection for any endangered species. No such species are known to exist in the Decker area.
7. Regulations pursuant to 23 U.S.C. 109(h) regarding Federal-aid highways require that possible adverse economic, social, and environmental effects relating to any proposed project on a Federal-aid system be fully considered in developing such a project, and that the final decisions on the project be made in the best overall public interest; 23 U.S.C. 109(h) also provides for State or local maintenance of Federal-aid systems highways. Included in this statute is the requirement that Federal-aid highways must be routed so as to minimize user costs.
8. Federal Regulations 43 C.F.R. 23, as they relate to Federal coal, have been replaced by 43 C.F.R. 3041 (see item 10).
9. Federal Regulations 30 C.F.R. 211 govern operations for the exploration, discovery, testing, development, mining and preparation of coal under coal leases, licenses, and permits issued for public domain and acquired lands pursuant to the regulations in 43 C.F.R. Group 3500. The purpose of the regulations in Part 211 is to promote orderly and efficient prospecting, exploration, testing, development, mining, and preparation operations and production practices without

waste or avoidable loss of coal or other mineral-bearing formation; to encourage maximum recovery and use of coal resources; to promote operating practices which will avoid, minimize, or correct damage to the environment, including land, water, and air, and avoid, minimize, or correct hazards to public health and safety; and to obtain a proper record and accounting of all coal produced.

It is the operator's obligation to "avoid, minimize, or repair" damage to the environment. The Mining Supervisor shall inspect the operations to determine the adequacy of water-management and pollution-control measures for the protection and control of the quality of surface-water and ground-water resources and for the protection and control of air quality. The operator shall take such action as may be needed to avoid, minimize, or repair soil erosion, pollution of air, pollution of surface or ground water, damage to vegetation growth, and injury or destruction of fish. All operations must be consistent with Federal and State water-quality and air-quality standards. The Mining Supervisor may require an operator to maintain records of the use of water, the quantity and quality of waste water produced, and the disposal of waste water; and he may require the operator to install a suitable monitoring system. Accidents that could cause water pollution shall be reported promptly to the Mining Supervisor.

Plans shall be submitted that provide for but are not limited to: (1) Reclamation of the surface of the lands affected; (2) measures to be taken to prevent soil erosion, pollution of surface and ground water, pollution of air, and damage to natural resources; (3) estimates of quantity of water to be used and pollutants that are expected to enter any receiving waters; (4) designs for necessary impoundment, treatment, or control of all runoff water and drainage from the mining activities, so as to reduce soil erosion and sedimentation and to prevent pollution of receiving waters; (5) a description of measures to be taken to prevent or control soil erosion or pollution of surface and ground water; and (6) proposed methods of revegetation and reclamation. Further the plan shall show proposed methods and timing of grading and backfilling of those areas affected by the operations. In addition, holes drilled for development or prospecting shall be abandoned to the satisfaction of the Mining Supervisor by cementing and/or casing or by other methods approved in advance to protect any underground deposit or water strata. However, at the option of the Mining Supervisor or operator, such holes may be converted to monitoring wells for determining the effects of the operation on quantity or quality or pressure of ground water.

10. Revisions to Federal Regulations 30 C.F.R. 211 together with a new subpart 3041 of 43 C.F.R. were published in the Federal Register on September 5, 1975. Final 43 C.F.R. 3041 and 30

C.F.R. 211 regulations were published and became effective on May 17, 1976. The new subpart 3041 replaces the 43 C.F.R. 23 regulations, as they relate to Federal coal, and covers surface management, regardless of ownership. The revisions "delete obsolete provisions, update existing regulations so as to impose reclamation and performance standards upon operations relating to Federal coal, and clarify the responsibility of lessees, permittees, and licensees for the protection of the surface, natural resources, environment, and existing improvements during all such operations."

A proposed mining and reclamation plan must specify all the requirements of the recently promulgated regulations of 43 C.F.R. 3041 and 30 C.F.R. 211 concerning Federal coal leasing and mining operations (Federal Register, V. 41, No. 96, May 17, 1976). No mining plan will be approved by the Mining Supervisor which does not provide for adequate reclamation consistent with performance standards contained in the new regulations.

Under section 43 C.F.R. 3041.0-5 (b)(1)(iii)(B) of the new regulations, the proposed East Decker and North Extension mines qualify as existing operations. Therefore, on and after November 13, 1976, (180 days after approval of the new regulations) the reclamation and performance standards (30 C.F.R. 211.40) of the new regulations will apply to the proposed mines as provided in section 30 C.F.R. 211.1 (d)(1). In addition, on or before November 15, 1977, (18 months after the approval of the new regulations) the Decker Coal Co. is required to submit to the Mining Supervisor and obtain his approval of a mining plan or modified mining plan that conforms entirely to the new regulations.

If the Decker Coal Co. cannot comply with the new performance standards of the mining regulations or if the company proposes a postmining land use that is substantially different from the land use immediately prior to mining, a variance from the performance standards must be obtained from the Mining Supervisor before the mining plan can be approved (30 C.F.R. 211.40 (a)(2)).

Under section 43 C.F.R. 3041.4 and 30 C.F.R. 211.5, substantial public participation, including a public hearing, is required in the approval or modification of a mining plan, release of a bond, or abandonment of a mine. If a public hearing on an environmental impact statement (EIS) pursuant to section 102 (2)(C) of the National Environmental Protection Act (NEPA) of 1969, as ammended, has previously been conducted, in which all major issues and proposed terms and conditions of any such proposed decision or action have been considered, and with respect to such meeting, all notice requirements have been met, the EIS hearing will satisfy the public meeting provision of the new regulations.

Public hearings on the draft environmental statement (DES) for the proposed East Decker and North Extension mines were held one day each at a location in the Decker area, at Billings, Montana, and at Sheridan, Wyoming, on November 16-18, 1976. These hearings will most likely also become the required public hearing for the proposed East Decker and North Extension mining plans.

11. Federal Regulations 33 C.F.R. 29.120 pursuant to Section 404 of the Federal Water Pollution Control Act, as amended, require that the Decker Coal Co. obtain a permit from the Department of the Army, Corps of Engineers, prior to the start of any construction that would result in the discharge or placement of dredged or fill material within the Tongue River Reservoir. The objective is to minimize water pollution and impacts on fish and wildlife and historic, scenic, and recreational values.

12. Federal Regulations 36 C.F.R. 800 pursuant to the National Historic Preservation Act of 1966 (80 Stat. 915, 16 U.S.C. 470) and Executive Order 11593, May 13, 1971 (36 FR 8921, 16 U.S.C. 470) establish procedures for the protection of historic and cultural properties.

    Section 106 of the National Historic Preservation Act requires that Federal, federally assisted, and federally licensed actions affecting properties included in the National Register of Historic Places be submitted to the Advisory

Council on Historic Preservation for review and comment prior to the approval of any such actions by the Federal agency.

Section 1(3) of Executive Order 11593 requires that Federal agencies, in consultation with the Council, establish procedures regarding the preservation and enhancement of non-federally owned historic and cultural properties in the execution of their plans and programs.

Section 2(a) of Executive Order 11593 requires Federal agencies to locate, inventory, and nominate properties under their jurisdiction or control to the National Register.

Compliance with procedures set forth in 30 C.F.R. 800 requires that the U.S. Geological Survey consult with the Montana State Historical Preservation Officer. Comments of the State Historical Preservation Officer must be forwarded to the Executive Director of the Advisory Council on Historic Preservation for review and comment, if necessary, before approval of a mining permit for either of the proposed operations.

13. Federal Executive Order No. 11514 requires the Federal Government to "provide leadership in protecting and enhancing the quality of the Nation's environment."
14. Federal Executive Order Number 11514 calls for procedures to monitor and enhance the aquatic environment.

3. State laws

Significant State laws for mitigating impacts include:

1. The Montana Strip and Underground Mine Reclamation Act (Chapter 10 of Title 50 R.C.M. 1947) and rules adopted thereunder (subchapter 10 of Chapter 10, Title 26, Montana Administrative Code) are summarized by the Montana Environmental Quality Council (1973) as follows:

"The Reclamation Act (passed in 1971, amended in 1973) (Note: the Act was also amended in 1974 and 1975) requires that any person intending to remove by strip mining more than 10,000 cubic yards of coal, uranium, and or overburden must obtain a permit from the Department of State Lands.

"Permits are issued for a period of one year and must be renewed annually. An application for a permit must include a plan for the mining operation and for the reclamation, revegetation, and rehabilitation of the land and water affected by the mine. The law requires a detailed pre-mining inventory of the natural man-made characteristics of the mining area including vegetation, wildlife, soils overburden, surface and ground water hydrology, ownership patterns, location of all water, oil, and gas wells, roads and utility lines. During the operation of the mine continued water quality, soil and overburden sampling is required.

"Area strip mining, a method of operation which does not produce a bench or fill bench, is required. Furthermore the mined area must be restored to approximately its original contour and topsoil must be conserved. To insure that the provisions of the permit are carried out, a bond must be filed with the department for an amount determined by the board based on the characteristics of the area to be mined. The bond may be neither less than $200 nor more than $2,500 for each acre or portion of an acre to be mined, provided that the bond equals the estimated amount that would be required for the state to complete work described in the reclamation plan. Return of the bond is contingent on the mine operator's faithful performance in completing the act's requirements. In no case can a bond be released sooner than five years after revegetation.

"In addition to forfeiture of bonds, the department may enforce the law through the suspension of existing permits or in the case of a mine operator who has more than one permit, the denial of permission to mine lands under the other permits. Civil and criminal penalties are provided for in the act, and the right to seek mandamus in district court to compel state officials to perform their duty under the act is granted to all residents of the state."

Upon receipt of a surface-mine permit application, the Department initiates a review of the application for completeness and conformance with provisions of the Reclamation Act and rules adopted thereunder. The Act and promulgated rules contain detailed standards regarding the method of mining, blasting, subsidence stabilization, water control, backfilling, grading, highwall reduction, topsoiling, and for the reclamation of lands affected by the proposed mining operations. As provided for in the Act, the Department has a maximum review period of 240 days within which to reach a decision regarding a permit application; however, the 240 day time span does not begin until all information required by the Act and rules is submitted to the satisfaction of the Department.

To ensure compliance with the Reclamation Act, the Department is required to make such mine inspections and investigations as necessary. The Department can refuse to issue a permit for mining in areas that meet the Act's criteria for selective denial (see Administrative alternatives available to the Department of State Lands (p. 662-663). To minimize detrimental impacts, the Department may conduct studies or encourage others to conduct studies of strip mining and strip-mined land reclamation. Finally the Act specifies that the Board of Land Commissioners may reclaim strip-mined lands using funds received from bond forfeiture, from the State or Federal government, or from other sources.

2. The Strip Mined Coal Conservation Act (Chapter 14 of Title 50, R.C.M. 1947) and administrative rules adopted thereunder (subchapter 14 of Chapter 10, Title 26, Montana Administrative Code) requires that any person intending to remove more than 10,000 cubic yards of coal or overburden by strip mining must first obtain approval of a strip-mining plan from the Department of State Lands. The intent of the Coal Conservation Act is to prevent waste of marketable coal. Marketable coal is defined as "strippable coal that is economically feasible to mine and is fit for sale in the usual course of trade."

The mining plans, once approved, are effective for one year from the date of approval. A mining plan must include provisions for the removal and utilization of strippable and marketable coal located within the area to be mined. The department may require an operator to submit, in addition to the mining plan, any information it deems necessary to determine whether waste would occur. Moreover, the department may make any inspections and investigations it deems necessary for review of a plan.

If a strip-mining plan is disapproved under the Coal Conservation Act, the operator has the right of appeal and a hearing before the Board of Land Commissioners. Civil penalties may be imposed on those who fail to obtain an approved strip-mining plan prior to mining or on those who do not comply with the terms of an approved plan.

3. Section 81-103 of the Montana Codes R.C.M. 1947 requires that the Board of Land Commissioners manage State-owned lands under the multiple use concept as follows:

> "***the management of all the various resources of the state lands so that they are utilized in that combination best meeting the needs of the people and the beneficiaries of the trust, making the most judicious use of the land for some or all of those resources *** without impairment of the productivity of the land, with consideration being given to the relative values of the various resources."

4. Section 81-501 of the Montana Codes R.C.M. 1947 authorizes the State Board of Land Commissioners to grant coal leases. Lessees agree to take such precautions as necessary to minimize soil erosion, water pollution, and damage to range improvements or crops (see Appendix A). The process of mining, handling, and marketing of State coal must prevent, insofar as possible, all waste of coal, and all mining operations must be conducted in a systematic and orderly manner that would not make subsequent mining operations more difficult or expensive. A violation of any of these conditions is grounds for forfeiture of the lease after a hearing before the Board. Every holder of a producing State coal-mining lease must (1) report monthly the amount, price received, and total amount of all sales for the previous month and (2) pay royalties monthly at the rate specified in the lease.

5. Montana's Clean Air Act (Chapter 39 or Title 69, R.C.M. 1947) and administrative rules adopted thereunder (subchapter 1 of Chapter 14, Title 16, Montana Administrative Code) defines air pollution and provides that the Board of Health and Environmental Sciences may prohibit

> "...the construction, installation, alteration, or use of any machine, equipment, device or facility which it finds may directly or indirectly cause or contribute to air pollution or which is intended primarily to prevent or control the emission of air pollutants, unless a permit therefore has been obtained from it."

6. Montana's Water Pollution Control Act (Chapter 48 of Title 69, R.C.M. 1947) and administrative rules adopted thereunder (subchapter 10 of Chapter 14 Title 16, Montana Administrative Code) charges the Department of Health and Environmental Sciences with the responsibility of regulating water quality by administering a permit system.
7. The State Antiquities Act, (Chapter 25 of Title 81, R.C.M. 1947) which is administered by the Board of Land Commissioners and the Department of State Lands, provides for the registration and protection of historic, prehistoric, archaeologic, paleontologic, scientific, or cultural sites and objects on State lands. It also provides that the Department is authorized to enter into cooperative agreements with private landowners to preserve, mark, maintain, excavate, or otherwise deal with such sites and objects upon such terms as may be agreed upon.
8. The Montana Resource Indeminity Trust Act (Chapter 70 of Title 84, R.C.M. 1947, and rules adopted thereunder (subchapter 14 of Chapter 14, Title 42, Montana Administrative Code) provides for a tax on mineral production (including coal). The taxes are paid into the resource indemnity trust account. The trust account will be allowed to accumulate until it reaches the amount of one hundred million dollars, at which time the

legislature is empowered to appropriate net earnings and all receipts for improvement of the environment and rectifying damages thereto.

9. Coal Severance Tax Act (Chapter 13 of Title 84, R.C.M. 1947) and rules adopted thereunder (subchapter 6 of Chapter 14, Title 42, Montana Administrative Code) impose a severance tax of up to 30 per cent of the value of coal removed by surface mining methods. The taxes collected are allocated as follows:

> "(1) To the county for such purposes as the governing body of that county may determine from which coal was mined for each calendar year prior to January 1, 1980, three (3¢) per ton or four percent (4%) of the severance tax paid on the coal mined in that county, whichever is higher, and for each calendar year following December 31, 1979, three cents (3¢) per ton or three and one-half percent (3½%) of the severance tax paid on the coal mined in that county, whichever is higher.
>
> "(2) Two and one-half percent (2½%) of total collections per year until December 31, 1979, and thereafter four percent (4%) of total collections per year to the earmarked revenue fund, to the credit of the alternative energy research development and demonstration account.
>
> "(3) Twenty-seven and one-half percent (27.5%) of total collections per year, until July 1, 1979, and thereafter thirty-five percent (35%), to the earmarked revenue fund to the credit of the local impact and education trust fund account.
>
> "(4) For each of the four (4) fiscal years following the effective date of this act ten percent (10%) of total collections per year to the earmarked revenue fund to the credit of the coal area highway improvement account.
>
> "(5) Ten percent (10%) of total collections per year, to the earmarked revenue fund, for state equalization aid to public schools of the state.
>
> "(6) For the period ending December 31, 1979, one percent (1%) of total collections per year to the earmarked revenue fund, to the credit of the county land planning account.

"(7) Two and one-half percent (2½%) of total collections per year to the sinking fund, to the credit of the renewable resource development bond account.

"(8) Two and one-half percent (2½%) of total collections per year through June 30, 1979, of which portion one-half (½) shall be allocated to the earmarked revenue fund, for the purpose of acquisition of sites and areas described in section 62-304, subject to legislative appropriations, and one-half (½) shall be allocated to the trust and legacy fund, for the purpose of parks acquisition. Income from the fund established in this subsection may be appropriated for the acquisition of sites and areas described in section 62-304.

"(9) To the earmarked revenue fund, such portions of the severance tax as may be authorized by laws enacted in 1975.

"(10) All other revenues from license of severance taxes collected under the provisions of this chapter shall be deposited to the credit of the general fund of the state."

10. Section 32-2412 of the Montana Codes R.C.M. 1947 requires the seeding of borrow pit slopes and shoulders along Federal-aid or State highways using an adaptable perennial grass or combination of perennial grasses and legumes whenever establishment of a perennial grass cover on such sites appears advisible. Section 32-2813 of the Montana Codes R.C.M. 1947 requires the same treatment for county-road construction projects.

4. Local ordinances

There are no significant Big Horn County ordinances that would function to mitigate coal-development impacts from the two proposed Decker mines.

B. Reclamation plans

1. Topography

The Decker Coal Co. proposes only to round off all ridges and depressions in the mined areas such that all slopes except the final highwall would be reduced to 5 to 1 (20 percent) or less. The final highwall would be reduced to a slope of 20 degrees (36.9 percent) or less. Standard proposed reclamation procedures would be used for topsoiling and seeding.

Other possible mitigating measures that could be used, but have not been proposed by the Decker Coal Co., include (1) the use of box-cut spoils, insofar as feasible, to largely fill the final cuts and thereby significantly reduce the height of the ridges and the depth of the final depressions; (2) reduction of slopes, insofar as practicable, to less than 10 percent to promote slope stability; (3) approximate reconstruction of principal stream valleys such as Middle and Coal Creek valleys in the East Decker area and Spring and Pearson Creek valleys in the North Extension areas; and (4) where haul-road depressions are to be left as topographic features, they should be constructed with broad curves that resemble the meandering course of natural stream valleys.

If the principal stream valleys in the East Decker and North Extension areas are not approximately reconstructed, the proposed mining plans for these areas probably would not meet performance standard 30 C.F.R. 211.40 (a)(2), which requires the operator to restore the reclaimed surface to the approximate original contour. In that event, the Decker Coal Co. must obtain a variance pursuant to 30 C.F.R. 211.74.

2. Soils

Measures that could be used to mitigate impacts from soil disturbances caused by surface mining are of two general types: (1) Those that enhance the suitability of the replaced soil materials as a medium for plant establishment and growth and (2) those that reduce runoff, erosion, and consequent sediment yield to the Tongue River Reservoir. The reader is referred to section IV. B. 5., Vegetation for a discussion of measures that primarily benefit reestablishment of a suitable plant cover. The following discussion attempts, insofar as practicable, to avoid repetition of mitigating measures that primarily benefit the plant cover. Because of the dominant effect of vegetation on runoff and erosion control, however, some discussion of factors affecting vegetation reestablishment is necessary.

a. Proposals of the Decker Coal Co.

Proposed reclamation plans for areas disturbed by mining operations include the removal by scrapers and salvage of all materials suitable for use as topsoil. These soil materials would be removed immediately preceding each step of the mining operation to avoid exposing large expanses of denuded areas to accelerated erosion. During the initial stages of mining and construction, all salvable soil materials would be stockpiled for later use. During this operation soil horizons would be intermixed. These stockpiles would be located in areas where they would not be disturbed by ongoing mining operations, and materials would be handled so as to avoid unnecessary compaction or contamination. A suitable plant cover would be established, if necessary, to prevent excessive erosion by wind or water. Stockpiled soil materials would not be rehandled until they are replaced on regraded areas in conjunction with reclamation. As mining progresses, soil materials removed in advance of mining would be transported by scrapers and placed on recontoured spoils in one operation, avoiding insofar as possible the need to stockpile. This approach would avoid possible compaction, contamination, and loss by erosion of stockpiled soil materials and also would avoid the inevitable reduction in biological activity that accompanies prolonged stockpiling of soils.

Loss of topsoil materials by erosion would be minimized by reducing all slopes except the final highwall to 5 to 1 (20 percent) or less, and by placing topsoil on recontoured spoils within a 90 day period prior to revegetative seeding or planting as required by the Montana Strip and Underground Mine Reclamation Act. The final highwall would be reduced to a slope of 20 degrees (36.4 percent) or less. A conscientious effort would be made to revegetate all disturbed areas as promptly as possible (see section IV. B. 5.).

To bond the soil veneer to the underlying spoil materials and thereby prevent soil slippage and the onset of rill and gully erosion, topsoil would be placed on the recontoured spoils in two applications using push-pull scrapers (fig. 7). An initial layer of 8 to 10 inches of topsoil would be placed and disced to provide a bond with the underlying spoils. A final layer of topsoil, the thickness depending on the availability of suitable materials for topsoiling, would be placed over the first layer and a seedbed prepared. Available data (table 11 and figs. 39 and 40) indicate that most existing soils in the East Decker and North Extension areas would be suitable for use in reclamation. In all probability, therefore, use of materials in the C horizon to supplement those in the A and B horizons would result in a replaced layer of topsoil averaging at least 18 inches deep over all disturbed areas. In any event, it should be stressed once again that all suitable materials would be salvaged and used as topsoil as required by the Montana Strip and Underground Mine Reclamation Act, thereby assuring the maximum possible thickness of topsoil on reclaimed areas.

Impacts related to the few sodic-soils problems would be minor and could be avoided by burying all materials not conducive to revegetation more than 8 feet below the surface of the regraded spoil.[1/] For example, spoils with high SAR values obtained from below the uppermost coal bed need not be placed on top of the spoil piles as normal stripping practices dictate. Instead, the dragline could swing past 90 degrees to place this material ahead of the spoil in the bottom of the adjacent pit. This practice would allow 35 feet or more of nonsodic materials to be placed over the sodic spoils. No sodic-soils problems are expected in the East Decker area. Sodic-soils problems in the North Extension area probably can be avoided by not salvaging soils from mapping units 1, 6, and 16 (fig. 37) for use as topsoil during reclamation and by adequate testing and special handling of overburden materials in the extreme northern, and possibly the

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[1/] The Department of State Lands rules and regulations adopted pursuant to the Montana Strip and Underground Mine Reclamation Act require that:

> "Materials which are not conducive to revegetation techniques, establishment, and growth shall not be left on the top or within eight (8) feet of the top of regraded spoils or at the surface of any other affected areas. The Department may require that problem materials be placed at greater depth. (MAC 26-2.10(10)-S10310(1)(b)"

A proposed replacement for the above rule has been submitted to the Department by a Technical Advisory Committee. For a discussion of the proposed rule change please see the response to the letter from the Decker Coal Co.

western part of the proposed mine area where the overburden might be locally high in sodium. Similarly, overburden materials containing more than 1 ppm plant-extractable nickel (p. B-4 and table B-1) should be buried more than 8 feet below the surface of the regraded spoil.

When use of roads is discontinued, the surface material would be removed, and reused where feasible or buried at suitable depth. The road and adjacent area then would be shaped, topsoiled, and seeded at the earliest appropriate time, not to exceed 90 days. Other disturbed areas would be reclaimed similarly, as rapidly as operations permit.

In addition to the above proposals, Montana rules and regulations pursuant to Title 50, Chapter 10, R.C.M. 1947, require that the Decker Coal Co. take the following actions:

1. In the case of abandoned roads, the roadbeds shall be ripped, disced, or otherwise conditioned before topsoil is replaced.
2. If necessary, redistributed topsoil shall be reconditioned by discing, ripping, or other appropriate methods. (These treatments would tend to offset the reduction in porosity and permeability and the increase in bulk density that would occur as a result of soil removal and replacement).
3. Spoil surfaces shall be left roughened in final contour to eliminate slippage zones that may develop between deposited topsoil and heavy textured spoil surfaces.
4. The operator shall take all measures necessary to assure the stability of topsoil on graded spoil slopes.

b. Other possible mitigating measures

Mulching of soils and/or use of chemical soil conditioners would greatly improve the suitability of replaced topsoils as a medium for plant growth. By using appropriate treatments, the porosity, permeability, and bulk density of soils probably could be returned to essentially premining conditions. Soil structure and organic content in the A and B horizons should be restored in time by natural soil-building processes, thereby eventually offsetting related impacts caused by soil disturbances as a consequence of mining. Possible mulches include straw or a straw-asphalt mix of the type used by the Montana Highway Department.

Burial of surface materials containing native plants, plant propagules, and seeds at excessive depths that would retard vegetative regeneration of native species could be minimized by selective handling of the topsoil. Insofar as practical, soil materials from the combined A and B horizons excavated in advance of mining by the first pass of the scraper could be transported in one operation and used as the final topsoil layer in areas being reclaimed. Regeneration of a native plant cover could also be enhanced by appropriate seed mixtures and seeding methods, coupled with the use of mulching, fertilization, and sprinkler irrigation as necessary (see section IV. B. 5.).

Excessive erosion of replaced topsoil on slopes as steep as 36 percent cannot be prevented in the Decker area by establishment of a plant cover alone. The mean annual precipitation of about 12 inches, coupled with the frequent occurrence of droughts, limit the density and vigor of the plant cover in the absence of continued sprinkler irrigation. Erosion of unstable soil materials on slopes can be minimized, however, by (1) reducing all slopes as much as practicable, preferably to less than 10 percent, and by (2) contour furrowing on slopes less than 10 percent and contour trenching on slopes greater than 10 percent. These structural treatments prevent or retard runoff for several years until the plant and associated root development in treated areas is sufficient to provide the soils with a measure of resistance to erosion. According to Branson, et. al. (1966), the visible effects of contour furrows are often readily apparent long after the furrows have been filled and no longer store runoff. The long-lasting visible effects are attributed to changes in both physical and chemical characteristics of the soils. Analyses of soil samples from furrowed areas and adjacent unfurrowed areas showed that high concentrations of sodium salts near the surface were leached to depth in furrowed areas in a period of less than 10 years (fig. 66). Contour furrowing, therefore, also provides a possible method of leaching and reclaiming sodic soils.

Increased sediment yield to the Tongue River Reservoir from erosion of denuded areas could be prevented by construction of temporary dikes to intercept runoff from these areas and by diverting flows into temporary impoundments that would function as settling ponds.

3. Water resources

a. Ground water

(1) Proposals of the Decker Coal Co.

(a) Replacement of aquifers

Proposed reclamation plans include the replacement of spoil materials in the mined-out areas and, if necessary, the sorting of these materials as required by the Montana Department of State Lands pursuant to adopted rules

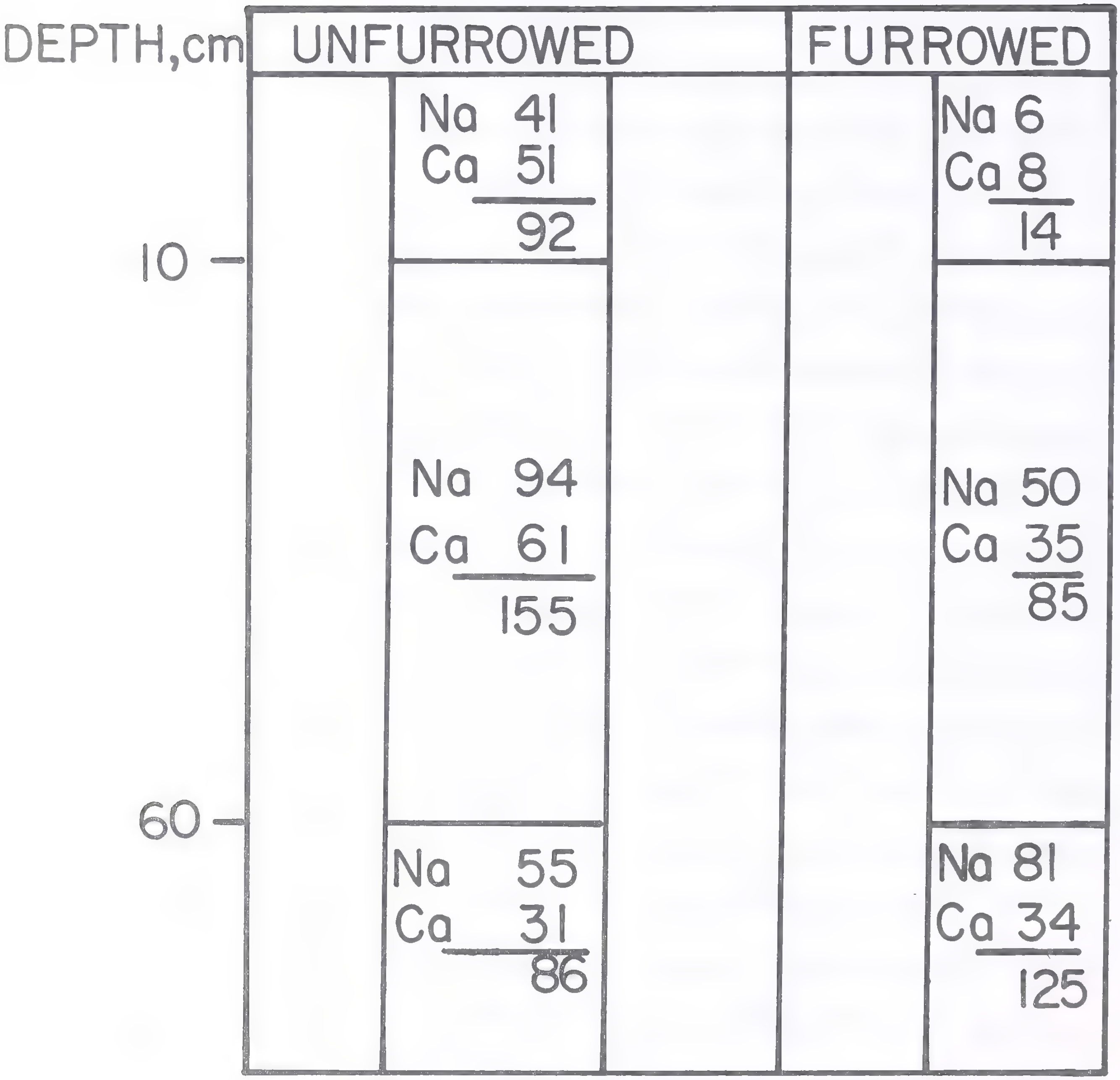


Figure 66.— Translocation of cations in contour-furrowed soil 10 years after treatment. Increased infiltration from furrowing caused a decrease in salts above 60 centimeters and an increase in salts below 60 centimeters. The cation quantities shown are milliequivalents per litre of saturated soil paste extract (from Branson, et al., 1966, fig. 12).

and regulations, Title 50, Chapter 10, R.C.M., 1947. Montana rules and regulations stipulate that material not conducive to plant growth shall be placed above the pit floor and at least 8 feet below the top of the regraded spoil. The unsorted bulk of the spoil would consist of a heterogeneous mixture of sandstone, siltstone, shale, alluvium, and clinker obtained from excavation of the overburden and interburden. The relative proportions of these materials would be determined locally by their abundance within the mined interval. In general, sandstone, siltstone, and shale would predominate in the East Decker area; clinker would predominate in the North Extension area.

The replaced spoil aquifer very probably would have a higher hydraulic conductivity and porosity than the undisturbed parent rock in the mined interval (p. 322). Consequently, the capacity of the spoil to store and transmit ground water probably would exceed that of the replaced sandstone and coal aquifers. In fact, the enlarged capacity of the spoil aquifer to store ground water could increase the quantity of ground water available for seasonal use. Moreover, gravity sorting of dragline-laid spoil materials (fig. 44) would tend to greatly increase the hydraulic conductivity of the lowermost part of the spoil aquifer, thereby enhancing ground-water circulation and consequent flushing of this basal part of the newly formed spoil aquifer. This flushing possibly might lessen the adverse effects of spoil leaching on the quality of the ground water moving laterally through the spoil.

(b) Restoration of ground-water movement

After mining operations have ceased, the premining pattern and rates of ground-water movement eventually would be reestablished. No mitigating measures would be required. Equilibrium would occur when accumulation of ground water in the mined area has raised the level of saturation to an elevation similar to, but perhaps slightly lower than the premining level. A slightly lower level of saturation is expected because of the inferred higher permeability of the spoil materials, and thus, a corresponding decrease in hydraulic gradient across the mined area to the reservoir. In all likelihood, the rate of ground-water movement through the spoil aquifer would be limited by the amount of recharge from the watershed and not by the permeability of the spoil aquifer.

(c) Treatment of mine effluent and waste water

Water entering the active pits from both ground-water and surface-water sources would be pumped into treatment ponds, which actually would function only as sediment-settling ponds inasmuch as the mine effluent would be neither acid or toxic and no other method of treatment would be required. Water discharged from these ponds to the Tongue River Reservoir would have the same dissolved solids content and the same specific ion concentrations as inflow to the ponds. The Decker Coal Co. must obtain National Pollutant Discharge Elimination System (NPDES) permits for both the East Decker and North Extension mines before effluent from these operations can be discharged into the Tongue River Reservoir. These permits are issued by the Montana Department of Health and Environmental Sciences with the approval of the U.S. Environmental Protection Agency, which has established minimum water-quality standards. Effluent from the West Decker mine currently meets established standards. Very probably, effluent from both the East Decker and North Extension mines also would meet those established standards. Should the standards be changed in the future, Decker Coal Co. would be required to treat the mine effluent as necessary to meet the new NPDES standards.

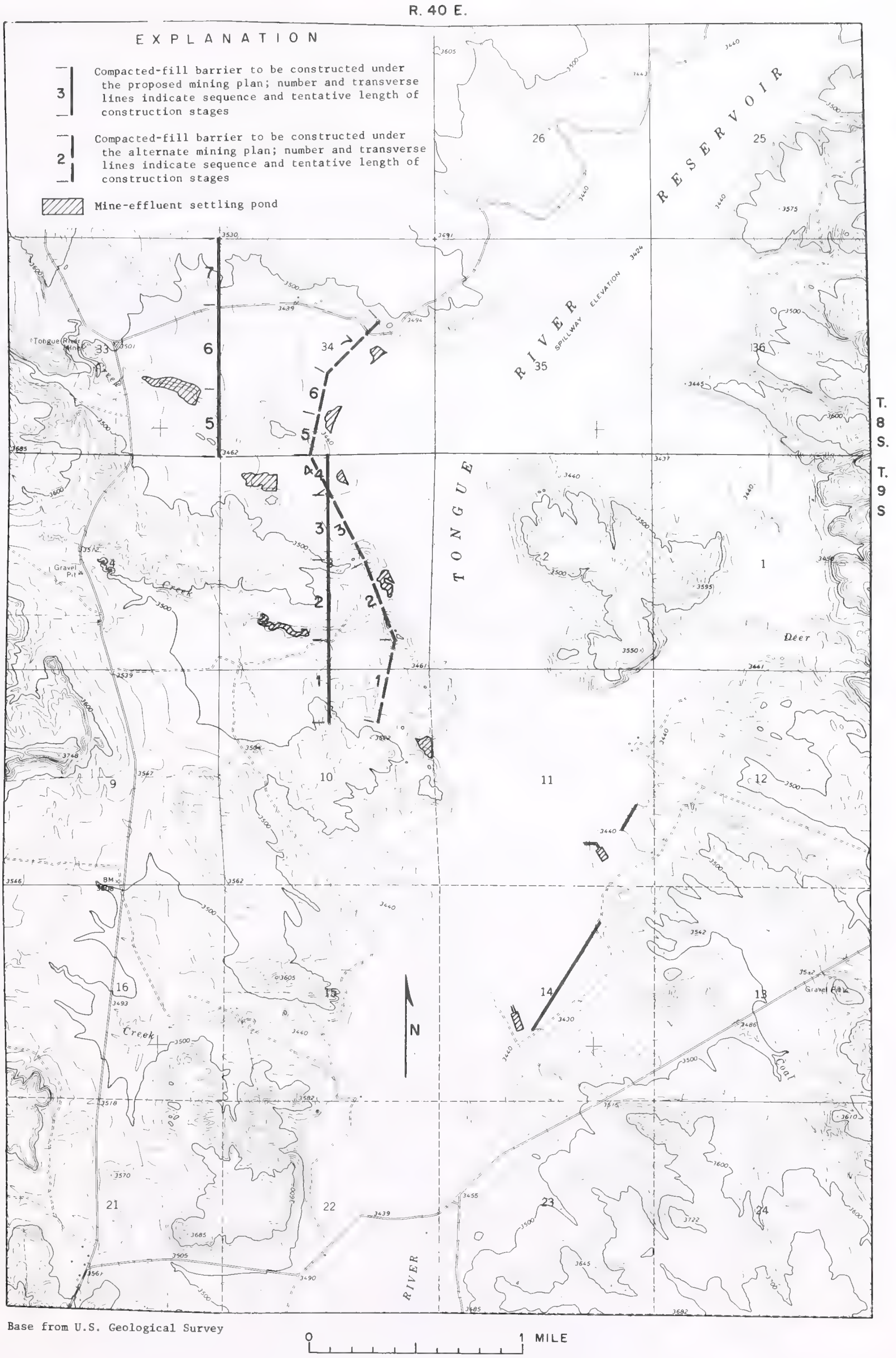
The Decker Coal Co. (written communication, Dec. 1, 1975) states that water treatment ponds constructed in the East Decker and North Extension areas would have sufficient capacity to provide a minimum detention period of 8 hours for all mine effluent. No capacity was reported in the initial mining plan for the two ponds to be built in the East Decker area (fig. 10), pending completion of on-going studies to determine the rate of ground-water inflow to the mine. VTN Colorado (1975a, p. 60) subsequently estimated that inflow to the East Decker mine would be about 127,400 gal/day (0.2 ft^3/s). Presumably, therefore, the Decker Coal Co. would expect to provide and maintain a total pond capacity of at least 45,000 gal (0.14 acre-ft) in the East Decker area. The two treatment ponds in the North Extension area (fig. 20) would have a total capacity of 150,000 gal (0.46 acre-ft) based on expected inflow to the mine of 50,000 gal/day.

Studies completed in conjunction with preparation of this environmental impact statement indicate much higher rates of ground-water inflow to both the East Decker and North Extension mines than those estimated by the Decker Coal Co. and by VTN of Colorado. Inflow to the East Decker mine one year after completion (table 34) is estimated to be 2 to 2.8 ft^3/s (1.3 to 1.8 million gal/day). Similarly, inflow to the North Extension mine (table 39) is estimated to be 7.8 to 10.4 ft^3/s (5.0 to 6.7 million gal/day). Obviously, effectual mitigation measures would require (1) correspondingly larger settling ponds than those proposed or (2) reduced ground-water inflow to the mines.

Personnel in the reclamation and engineering departments of the Decker Coal Co. were advised of the inferred high rates of ground-water inflow to the proposed mines and of the possibility that this inflow could be significantly reduced by the construction of ground-water barriers between the mines and the Tongue River Reservoir. According to tables 34 and 39, inflow to the East Decker mine could be reduced about 80 percent with properly designed and constructed barriers, and inflow to the North Extension mine could be reduced about 60 percent.

On December 1, 1975, the Chief Reclamation Engineer of the Decker Coal Co. submitted to the Reclamation Division, Montana Department of State Lands, proposals describing and depicting (1) the placement of compacted fills in the box cuts in both the East Decker and North Extension areas to retard ground-water inflow into the mines from the reservoir and (2) the location of additional settling ponds of sufficient capacity to contain the maximum anticipated volume of mine effluent. Those proposals also stated that the Decker Coal Co. was prepared to provide any additional storage for treatment of mine effluent that would be necessary should the inflow to the mines exceed expectations.

Two compacted-fill barriers (fig. 67) would be built in the East Decker area, one about 3,100 feet long across the mouth of Coal Creek valley and an adjacent embayment of the Tongue River Reservoir to the south, and one about 700 feet long across the mouth of Middle Creek valley. A diagrammatic cross-section showing the details of construction of these barriers is depicted in figure 68. As both ends of both barriers would abut low-permeability bedrock, virtually all inflow to the mines from the reservoir, as indicated in table 34, would be prevented. Therefore, inflow to the East Decker mine should be reduced to less than 0.7 ft^3/s (315 gal/min).



R. 40 E.
EXPLANATION
Compacted-fill barrier to be constructed under the proposed mining plan; number and transverse lines indicate sequence and tentative length of construction stages
Compacted-fill barrier to be constructed under the alternate mining plan; number and transverse lines indicate sequence and tentative length of construction stages
Mine-effluent settling pond
TONGUE RIVER RESERVOIR
SPILLWAY ELEVATION 3424
TONGUE
RIVER
Tongue River Mine
Gravel Pit
Creek
Deer
Coal
T. 8 S.
T. 9 S.
N
0
1 MILE

Base from U.S. Geological Survey

Figure 67.—Location of compacted-fill barriers that could be used to retard ground-water inflow to the proposed East Decker and North Extension mines from the Tongue River Reservoir.

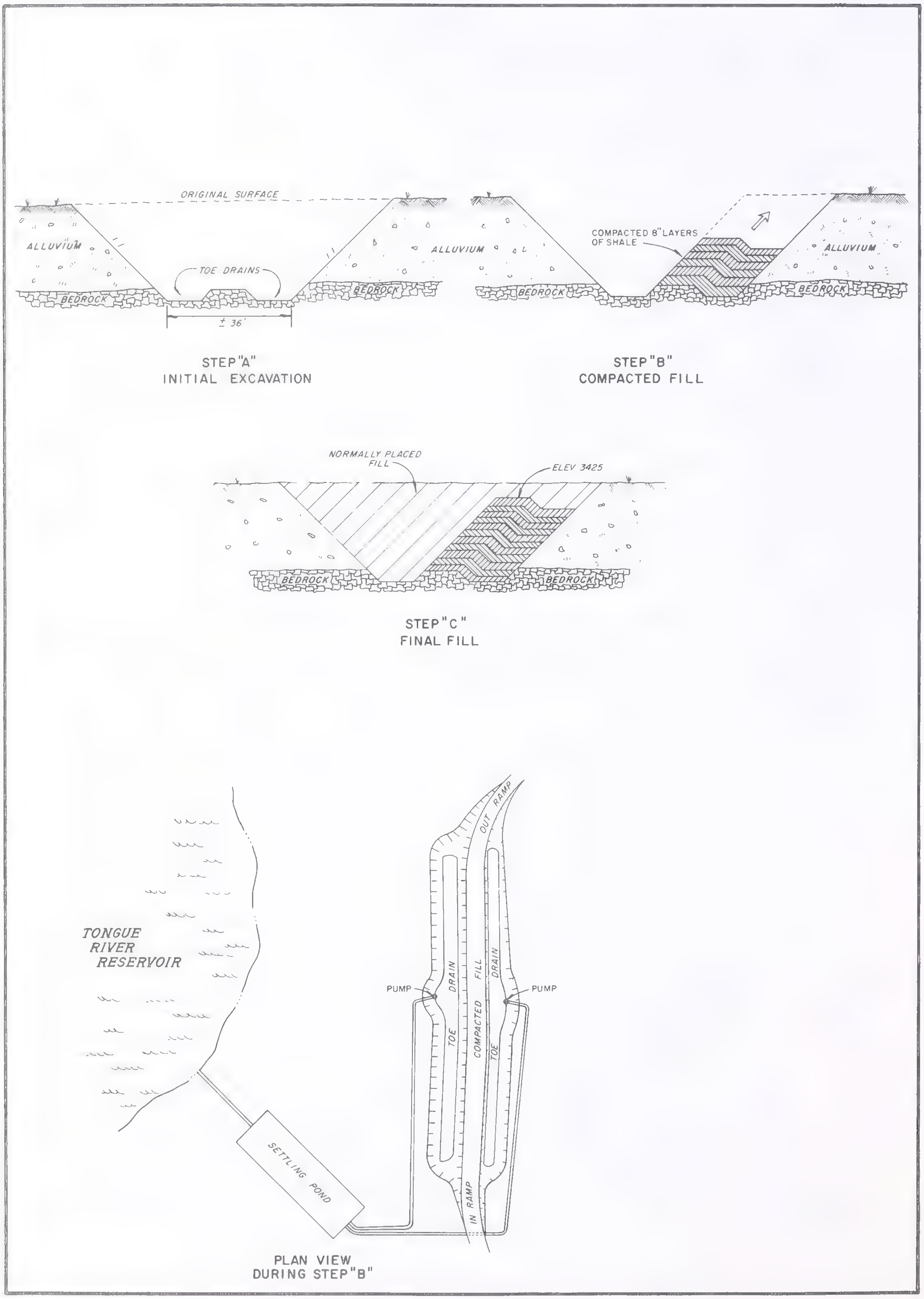


Figure 68.– Diagrammatic cross section showing details of construction of ground-water barriers in the East Decker area.

Similarly, two compacted-fill barriers (fig. 67) would be built in the North Extension area; one about 6,500 feet long would be placed within the southern box cut, and one about 5,200 feet long would be placed within the northern box cut. A diagrammatic cross-section showing the details of construction of these barriers is depicted in figure 69. If necessary, suitable fine-grained construction materials would be obtained from the West Decker mine.

The southern box cut and compacted-fill barrier tentatively would begin at the south end and be completed in four stages (fig. 67). The length of the cut in each stage would depend on the rate of inflow to the cut per unit length; the greater the rate of inflow to the cut per unit length, the shorter would be the length of cut. For example, greatest inflow is expected at the northern end of the southern box cut; consequently, this fourth-stage cut is tentatively shown on figure 67 as being only half as long (1,000 feet) as the first-stage cut (2,000 feet). Neither end of the southern barrier would abut low-permeability bedrock, as in the East Decker area. Therefore, considerable inflow to the southern pit from the reservoir is expected to occur through the clinker around the ends of the barrier after its completion.

The northern box cut and compacted-fill barrier would also begin at the south end and would be completed in three stages (fig. 67). The northern end of this barrier would abut low-permeability bedrock, but the southern end would be terminated in permeable clinker, thus allowing appreciable inflow to the northern pit from the reservoir.

Assuming the clinker to be uniformly permeable, the southern ground-water barrier, if completed as proposed, should reduce inflow to the southern pit from the reservoir by about 1.6 to 2.2 ft^3/s or about

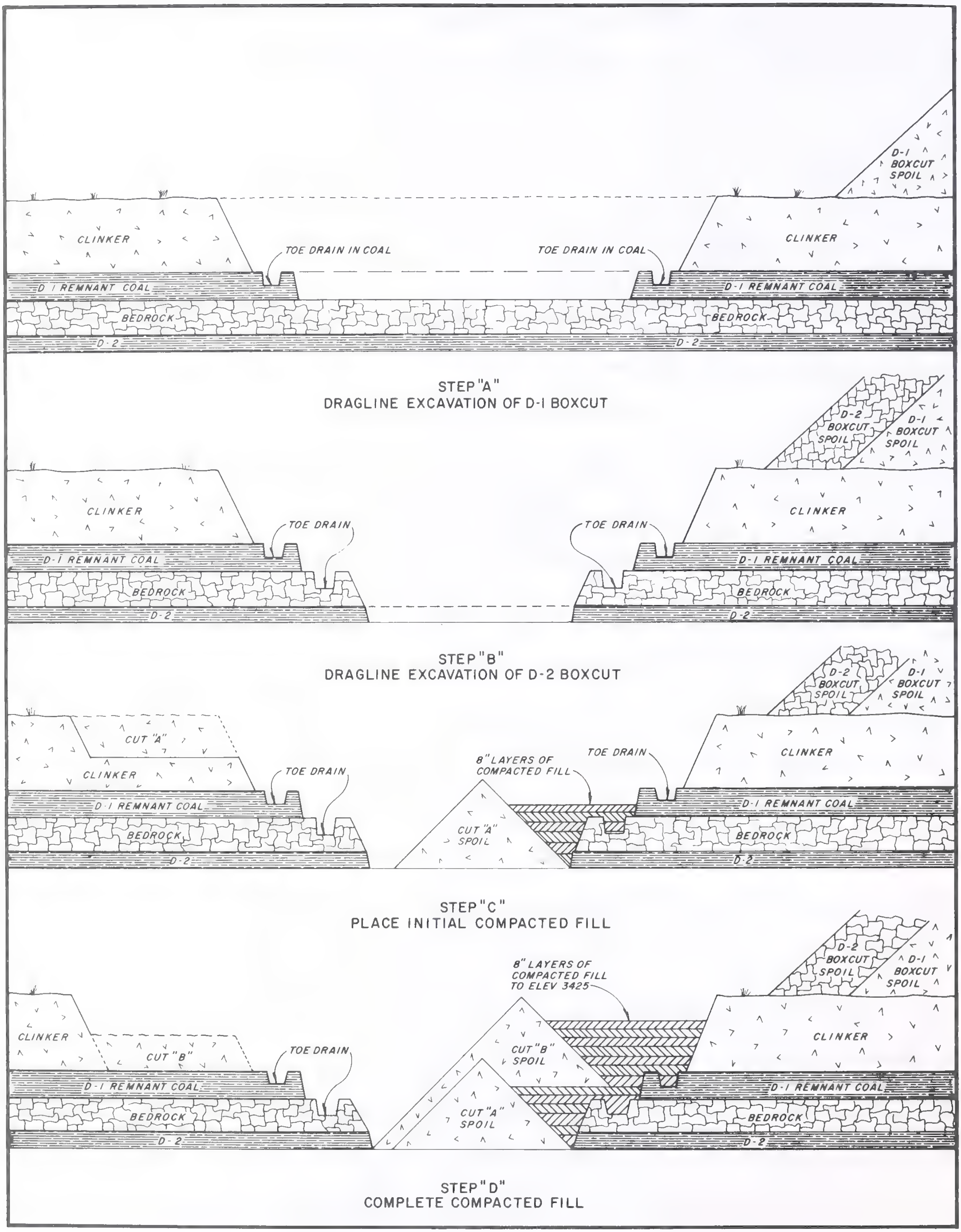


Figure 69.—Diagrammatic cross section showing details of construction of ground-water barriers in the North Extension area.

35 percent. Similarly, inflow to the northern pit from the reservoir should be reduced about 0.1 to 0.2 ft^3/s or about 30 to 50 percent. Total reduction of inflow to both pits from all sources (table 39 should be about 22 percent.

The inferred relative ineffectiveness of ground-water barriers in the North Extension area, compared to those in the East Decker area, is attributed to the lack of effective closure at both ends of the southern pit and at the southern end of the northern pit. This deficiency could be largely remedied by constructing (1) a west-trending barrier connecting the northern end of the southern barrier to the southern end of the northern barrier and (2) a second barrier extending westward from the southern end of the southern pit. These two west-trending barriers could be completed in conjunction with the mining operation by compacting fine-grained spoil materials at the north and south ends of the southern pit as that pit is extended westward. The result would be to progressively reduce inflow to the mine from the reservoir as the length of these west-trending barriers is increased. Inflow to the mine from the reservoir probably would be reduced 80 to 90 percent after the gap between the northern and southern barriers is closed and the west-trending barrier at the south end of the southern cut is more than half a mile long. If so, total inflow to the mine should be reduced 50 to 60 percent.

Because of the apparent high permeability of the clinker in the North Extension area and the close proximity of the reservoir to the mine, possibly the rate of ground-water inflow to the mine during excavation of the box cuts could be significantly reduced by coordinating this initial phase of development with reservoir stage (water level). Reservoir stage is generally highest in the period following spring runoff, during which time water enters the permeable clinker as bank storage. Conversely, reservoir stage is generally lowest in the period following the end of the irrigation season, during which time water drains from the clinker back into the reservoir. The level of saturation in the clinker, therefore, is generally lowest immediately prior to the period of spring runoff. It might be desirable, therefore, to time the excavation of the box cuts so that the length of pit having the inferred highest rates of inflow would be opened at the time of lowest saturation in the clinker.

The primary effect of the ground-water barriers after mining and reclamation operations are completed would be to greatly retard movement of ground water from the reservoir into the mined areas. This would significantly prolong the time required to reestablish approximate premining water levels in and flow rates through the dewatered areas, but would reduce accordingly water losses from the reservoir to the spoil aquifers. At the same time, the annual cyclical movement of water into and out of the clinker, which in effect increases the capacity of the Tongue River Reservoir, would no longer occur. As a result, the rate of flushing of the spoils materials would be decreased and the consequent degradation of water quality in the reservoir would be diminished accordingly. Eventually the spoil aquifers in the mined areas would become saturated to the level of the top of the barriers, and discharge again would occur to the Tongue River Reservoir at essentially the premining rates. It follows, therefore, that the ground-water barriers would have both beneficial and adverse impacts on the ground-water system after reclamation is completed. Depending on the desired effects, the barriers could be left intact to prevent cyclical ground-water circulation between the mined area and the reservoir, the barriers could be breached at a number of locations and backfilled with permeable clinker to restore cyclical ground-water circulation, or the barriers could be breached at a comparatively few locations to provide limited ground-water circulation. In any event the volume of water entering the spoils from the reservoir would probably not exceed a few hundred acre-feet annually. Consequent leaching of the spoils aquifer by this action would be minimal.

In addition to the ground-water barriers, two enlarged mine-effluent settling ponds would be built in the East Decker area and five would be built in the North Extension area (fig. 67). The two ponds in the East Decker area would have a total capacity of 650,000 ft^3 (14.9 acre-ft) and, allowing a minimum detention period of 8 hours, would accommodate an effluent discharge rate of as much as 23 ft^3/s. This is about seven times the maximum expected rate of discharge from the East Decker mine in the absence of ground-water barriers. The five ponds in the North Extension area would have a total capacity of 5,200,000 ft^3 (119 acre-ft). Allowing a minimum detention period of 8 hours, these ponds would accommodate an effluent discharge rate of as much as 180 ft^3/s, which is about 15 times the maximum expected rate of discharge from the North Extension mine in the absence of ground-water barriers.

It should be noted that placement of settling ponds within the North Extension mine area (fig. 67) would result in the recirculation of seepage losses from the ponds unless they are adequately lined or sealed. Even so, the capacities of the proposed settling ponds in both the East Decker and

North Extension areas are inordinately large and suggest a possible error in computation. That suspicion is reinforced by the rarrative submitted with the proposals of December 1, 1975, which indicates that ponds in the North Extension area were designed to accommodate a maximum effluent discharge of 20 ft^3/s. If so, pond capacity for an 8-hour detention period should be one-third of the daily discharge volume of about 40 acre-feet. Apparently, the daily effluent volume was multiplied by 3 instead of being divided by 3, thus inadvertently providing for a detention period of 72 hours and a pond capacity of 119 acre-feet instead of 13.3 acre-feet. Accordingly, the design capacity of the proposed settling ponds should be reviewed and revised as necessary to provide adequate, but not excessive, storage. In response to this suggestion, the Decker Coal Co. has stated that all settling ponds (fig. 67) would be constructed so as to provide a minimum detention period of 8 hours for all mine effluent. Care would be exercised to assure that these ponds would have adequate capacity but would not be excessively large.

The proposed clay-lined waste-water lagoons in the East Decker area (p. 52) should be adequate to evaporate all waste water from the plant area. No pollution of surface or subsurface waters should occur. No waste-water lagoons would be required at the North Extension mine, which would use existing West Decker mine facilities.

(d) Monitoring of ground-water levels and water quality

A network of observation wells has been completed in the Decker area (tables D-2 to D-4, Appendix D). The proposed monitoring system is described in section IV. B. 6. Should this monitoring system reveal any adverse impacts that might be mitigated by spoil management, corrective measures would be taken by the Decker Coal Co. to alleviate or at least ameliorate the problem.

(e) Replacement of ground-water supplies

Should mine operations interfere with any ground-water supply in the area, the Decker Coal Co. has stated that they would do whatever may be required to correct the problem.

(2) Other possible mitigating measures

(a) Replacement of ground-water supplies

Ground-water supplies lost or sufficiently impaired as a result of the proposed mining operations so as to require mitigating measures almost assuredly can be replaced in both quantity and quality by drilling 100 to 200 feet deeper to undisturbed coal aquifers such as the Canyon coal bed. Most of the ground-water supplies that would be impacted are obtained from wells that yield less than 10 gal/min of soft, iron-free water that contains less than 2,000 mg/l dissolved solids and is suitable for domestic and livestock use. Substitute supplies available from the underlying coal beds are similar in quality, and therefore, equally suited for the same uses. Yields in excess of 10 gal/min should not be difficult to obtain at depths of 200 to 400 feet below the surface.

Two of the three springs that probably would be adversely affected by mining operations in the North Extension area (p. 397) should resume flowing after the level of saturation in the mine area reaches the approximate premining level. No mitigations, therefore, should be necessary. Some uncertainty exists as to the ultimate fate of the spring in sec. 33, T. 8 S., R. 40 E., which physically would be disrupted by the mining operation. Because the land surface at this spring would be lowered by mining, prospects are very good that a spring would reoccur at this approximate location. If not, a suitable supply of water for livestock and wildlife could be developed at a depth of less than 25 feet.

b. Surface water

(1) Proposals of the Decker Coal Co.

The following measures proposed by the Decker Coal Co. to mitigate impacts to surface water are deficient in a number of respects. Those deficiencies are noted in the following text and addressed under Other possible mitigating measures (p. 552).

(a) Control of runoff

Recurrent flooding of the active pits would be prevented by construction of appropriate offsite diversion systems that would intercept runoff in streams entering the mine areas and would carry this runoff around the mine areas. Temporary contour ditches and impoundments would be constructed within the mine area to divert local surface runoff around the active pits.

The proposed diversion impoundments should function adequately over the life of the mining operations. The diversion channels, however, are designed for high flow velocities and almost certainly would fail or would require periodic maintenance. Failure would accelerate local erosion and possibly increase sediment yield to the Tongue River Reservoir.

Local short-term destruction or impairment of the plant cover during construction of the diversion system would be mitigated by reestablishment of the plant cover through appropriate soil ammendments and reseeding as necessary. The impact on the small animal habitat would be very local and short term and would not require mitigation.

The impact of the diversion system on the physical character and appearance of the landscape would be mitigated by removal of the diversion impoundments and channels after mining is completed and by restoration of the surface. An exception would be the Deer Creek diversion, which would permanently reroute runoff from the Deer Creek watershed as indicated on figure 9. The settling pond near the outlet of this diversion would be removed after mining is completed and the area restored. As stated on p. 345, the proposed Deer Creek diversion would eventually fail, probably within a period of less than 50 years. This failure would result in extensive erosion of the spoil materials that would be used to partially fill the lower reach of Deer Creek valley.

All wash waters, sanitary waste waters, and other process by-products waters would be collected and evaporated from lined waste-water lagoons. No discharge would occur from these lagoons to surface or ground waters in the area, and the possibility of spillage from local flooding is remote. Therefore, no mitigating measures are required. The lagoons would be removed and the area restored after mining is completed.

(b) Control of erosion and sedimentation

The Deer Creek diversion channel would be riprapped its full length to prevent erosion and consequent sedimentation in the Tongue River Reservoir. Erosion in other diversion channels in the East Decker and North Extension areas would be minimized by (1) proper application of engineering-design principles to maintain noneroding velocities[1/] (2) the use of diversion

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[1/] As previously stated, the proposed design for diversion channels in both the East Decker and North Extension areas generally would not meet this mitigating objective (see section IV. B. 3. b. (2) for additional mitigating measures).

impoundments to reduce peak discharges and thus reduce flow velocities in diversion channels, and (3) maintenance of the system as required.

Potentially increased sediment yield to the Tongue River Reservoir as a result of mining would be partially mitigated by trapping sediment in the diversion impoundments upstream from the diversion channels and in settling basins near the outlet of these channels. Surface runoff into the active pits would be pumped through settling ponds with the ground-water effluent, thereby decreasing the sediment load to the Tongue River Reservoir.

Other measures required by the Montana Strip and Underground Mine Reclamation Act include (1) leveling and contouring spoil materials no further than two spoil banks behind the active mining area, (2) replacing topsoil on this recontoured surface, and (3) reseeding no later than 90 days after topsoiling. All other areas disturbed by the mining operation would be revegetated as promptly as possible. Haul roads would be wetted as necessary and soil stockpiles would be revegetated to minimize wind erosion, soil loss, and air pollution.

Proposals also state that all slopes except the final highwall would be reduced to less than 5 to 1 (20 percent), which would increase slope stability and decrease erosion. It should be noted, however, that maps prepared by the Decker Coal Co. at a scale 1:6000, from which figures 9 and 19 were prepared, show many slopes averaging 20 to 25 percent and some slopes as high as 40 percent.

No mitigating measures are proposed to control erosion by wave action along the access road and railroad spur in the East Decker area and along relocated Route FAS 314 in the North Extension area.

(c) Restoration of principal stream channels removed by mining

Following the completion of mining and reclamation, diversion impoundments would be removed from Middle Creek, Coal Creek, Spring Creek, South Fork Spring Creek, and Pearson Creek valleys upstream from the mined areas. Runoff from these watersheds then would enter the reclaimed mine areas over the final highwall and would drain to the Tongue River Reservoir through depressions left in the reclaimed surface. The final highwall would be reduced to a slope of 20 degrees or less. No mitigating measures are proposed to prevent a headcut from forming at the highwall and migrating upstream. Similarly, no stable channel design is proposed across the reclaimed surface of the mine areas.

The sediment settling pond on Spring Creek downstream from the mine area (fig. 20) would be removed and the area restored. No mitigating measures are proposed, however, to prevent erosion downstream in the old channel of Spring Creek, which after mining would carry the combined flows of Spring and Pearson Creeks.

(d) Replacement of surface-water supplies

No measures are proposed to replace surface-water supplies currently used by wildlife and livestock that would be interrupted by mining.

(e) Monitoring of streamflow

A network of stream gaging stations has been completed in the Decker area by the Decker Coal Co. (fig. 70). The existing and proposed monitoring system is described in section IV. B. 6. Should this monitoring system reveal any adverse impacts that might be mitigated by modification of the diversion system or the reclamation methods, corrective measures would be taken by the Decker Coal Co. to alleviate or at least ameliorate the problem.

(2) Other possible mitigating measures

(a) Design of stable diversion channels to control runoff

With proper application of engineering-design principles, the diversion channels in the East Decker and North Extension areas could be constructed to function over the life of the proposed mines with a minimum of erosion and deposition. Such a system would require minimal maintenance. Some factors that might increase channel stability and performance are:

1. Selection of a practical "design" flow. The channels should carry with little or no erosion or aggradation the large number of relatively small flows that can be expected over the life of the operation. Some erosion might be acceptable from a 10-year flood, and moderate erosion might be acceptable from a 25-year flood. A channel of sufficient size to contain the maximum expected flow would be costly to construct and would seriously impact the environment. Any flows exceeding the design capacity of the system, which probably should not exceed a 50-year flood, would overflow into the mine area. The probability that a flood having a given recurrence interval will be exceeded in a specific time period is given in table 17.
2. Increased detention and retention storage could be provided in diversion impoundments to effectively reduce peak discharges from flows generated by intense short-duration rainfall in the smaller watersheds.
3. The use of noneroding flow velocities would greatly enhance channel stability. Flow velocities generally should not exceed 2 to 3 ft/s in noncohesive earthen materials or 6 to 8 ft/s in channels excavated in clinker or protected by a clinker riprap

lining. The higher limits apply to flows carrying moderate suspended sediment loads; the lower limits apply to comparatively sediment-free flows (U.S. Department of Agriculture, 1972a).

4. Clinker, which is a durable, locally abundant construction material, could be used as a protective riprap lining in diversion channels. The reddish-colored clinker would generally be compatible with the existing landscape, which includes numerous elongate talus slopes of clinker materials, roads surfaced with clinker, and channel reaches commonly containing reddish-colored alluvium.

   Clinker used as a channel lining should have a minimum thickness of 1 foot in noncohesive materials and preferably should be placed on side slopes of 2 or 2½ to 1 rather than 1½ to 1. The gradation of particle size obtained from the relationship

$$\frac{1}{2}\left[\frac{D_{50}}{D_{16}} + \frac{D_{84}}{D_{50}}\right]$$

   should be greater than 3 to assure reasonable placement density. D_{50} (particle size for which 50 percent of the material is smaller) in the range 1 to 3 inches and D_{75} (particle size of which 75 percent of the material is smaller) of 1½ to 5 inches would be desirable. Appropriate values of n for a clinker lining having the above size distribution should be 0.030 to 0.035.

5. If clinker, which generally has a specific gravity of less than 2.65, is used as lining, the design velocity should be adjusted by the factor

$$\frac{\text{specific gravity of clinker} - 1}{1.65}$$

or 0.9 in the case where the specific gravity of the clinker is 2.50.

6. The design of essentially stable diversion channels might largely eliminate the need for the proposed settling basins near the outlets of the channels or at least would greatly increase the functional life of these structures. In effect, the diversion impoundments would substitute as settling basins, provided that comparatively little sediment is added from tributary streams entering the stable channels downstream. Deposition of sediment in settling ponds or impoundments, however, tends to increase erosion in the channels downstream, because clear water is more erosive than sediment-laden flows. Appropriate adjustments in flow velocities should be incorporated in the design of the diversion system.

7. Concrete drop structures could be used instead of the proposed high-velocity concrete-lined channel sections to eliminate many of the problems associated with the transition from concrete to clinker or earthen channels and with cavitation, negative pressures, and energy dissipation. Moreover, the use of concrete structures with drops of up to 15 feet, as necessary, might permit improved channel alignment.

8. Local erosion could be reduced by incorporating provisions in the respective channel designs to accommodate direct inflow to the diversion channels from intercepted small ephemeral streams. For example, a channel having a contributing area of about 1.5 square miles discharges directly into the Deer Creek diversion channel about 1,300 feet downstream from the diversion structure on Deer Creek. The bottom of this tributary channel is higher than the bottom of the diversion channel. Thus, an appropriate drop structure and energy dissipator is necessary to prevent local scour and the formation of a headcut on this tributary channel. If the bottom of an intercepted channel is lower than the bottom of the diversion channel, aggradation would occur in the lower reach of the tributary until the depression is filled. In that event no mitigating measure would be required.

9. Stabilization of the Deer Creek diversion channel over the long term so that it would effectively function as a permanent drainage course for the Deer Creek watershed could be accomplished by constructing a channel having dimensions and floodplain width generally comparable to that of the existing valley downstream from the proposed point of diversion. Construction of a channel and floodplain of that magnitude, however, would be a major undertaking that would significantly impact the environment. Possible mitigations to impacts that would result from eventual failure of the proposed Deer Creek diversion

system are (1) removal of the diversion system after completion of mining and restoration of the premining channel through the lower reach of Deer Creek valley and (2) adoption of an alternate mining plan that would not require spoiling into Deer Creek valley and that would require construction of the railroad loop so as not to alter the existing flow regimen of Deer Creek. Adoption of such an alternate mining plan is discussed as an alternative to the proposed action (section VIII. E.).

(b) Measures to control erosion and sedimentation

As indicated in the foregoing discussion, construction of essentially stable diversion channels would significantly reduce local scour within these channels and consequent sediment yield to the Tongue River Reservoir during the period of mining. After the completion of mining and the removal of the diversion systems (p. 41 and 69), a far greater quantity of sediment probably would be generated by trenching of the principal stream valleys upstream from the final highwalls. Basically, this valley trenching and related impacts could be prevented in two ways. The idealistic approach would be to restore the surface in the mined areas so that channels would have essentially the same slope and channel dimensions as before mining. This approach, however, would be generally impractical and probably economically unfeasible under the proposed mining plans for both the East Decker and North Extension areas.

An alternative approach that should be both technologically and economically feasible would be to design and construct essentially stable channels that would carry flows over the highwall, dissipate any excess energy, and direct flows into the depressions left for that purpose in the reclaimed surface. Such channels probably would require periodic maintenance over the long term. Some mitigating measures that might enhance the performance and long-term stability of these engineered channels and that might improved their compatibility with the existing environment are as follows:

1. Long-term stability could be enhanced primarily by reducing the slope of channels over the final highwalls to the maximum extent practicable. This could be done feasibly by cut and fill methods. Materials cut from the upper part of the highwall in the valley bottom immediately upstream from the mined area could be used to partially fill the depression downstream, thereby effectively reducing the slope of the highwall. Additional fill materials could be obtained from spoils in the mined area adjacent to the final cut and possibly by hauling some box-cut spoils.
2. Erosive velocities could be prevented in channels over the highwall by constructing them at a width comparable to that of the floodplain of existing channels immediately upstream from the highwall.
3. The use of clinker as a construction material would be consistent with the existing environment. These materials should be of a size that would be essentially stable at all expected discharges. (Some hydrologists doubt that loose rock rubble such as clinker would remain stable over the long term and believe that

gabion-type construction using wire baskets would be necessary. Research is needed to determine the relative merits of different methods of stable channel construction as this problem will be common to most proposed mining operations in the semiarid West).

4. Materials used as channel lining could be sized and placed so that channel roughness would not decrease with time as a result of sediment accumulation. The irregular channel bed should be self cleaning of any accumulated sediment during moderate and larger runoff events. Estimated flow velocities during a 100-year flood, based on the Manning equation and on appropriate values of channel roughness, should be subcritical (Froude number of less than 1).

5. Because clear water is more erosive than sediment-laden water, the stability of a channel carrying flows over the highwall would be jeopardized by continued deposition of sediment in the aggrading reach upstream from the highwall. This deposition would be initiated by construction of the diversion impoundment and would continue after removal of the impoundment and restoration of the surface. Eventually, a headcut would form on the oversteepened reach at the restored site of the diversion impoundment and would migrate upstream, incising a trench through sediments deposited in the aggrading reach. Thereafter, runoff from the watershed, together with its sediment load, would move unabated downstream and over the highwall. As the aggrading reach would eventually be trenched by natural

process, consideration could be given to constructing a meandering channel across the aggrading reach at the time the channel over the highwall is completed. The effect would be to increase the initial sediment load and thus, enhance the initial stability of the highwall channel during periods of runoff.

6. Scenic and esthetic values could be maintained by selecting a channel design, construction materials, and restored plant cover that would be compatible, insofar as possible, with the existing environment.

No mitigating measures generally would be required to stabilize channels extending downstream from the highwall across the reclaimed mined areas. With the exception of the reach extending downstream from the highwall on Spring Creek to the mouth of South Fork Spring Creek, the slope of all channels following depressions across the reclaimed mined areas would be equal to or less than the slope of the premining channels. Aggradation would occur (p. 351 and 412) in these flattened reaches and eventually, through natural geomorphic and edaphic processes, would result in the establishment of stable, vegetated channels across the mined areas. These natural processes would not adversely impact the environment. The natural riparian plant cover that would develop on these aggrading valley bottoms should be similar to that on other flood-plain deposits in the area.

Miscellaneous mitigating measures that could be applied to reduce erosion and sediment yield to the Tongue River Reservoir are:

1. Reduction of the slope of the channel downstream from the highwall on Spring Creek to less than 0.007.

2. Periodic removal of sediment from settling ponds at the lower ends of the proposed diversion channels, as necessary, to maintain their effectiveness. Any sediments excavated from these ponds should be disposed of in a manner that would not adversely impact the environment. Possibly, these materials could be used for topsoiling.
3. Reduction of all slopes within the mined areas to less than 10 percent, insofar as feasible.
4. Modification of the reclaimed surface in the North Extension area to leave a depression across the mined area coinciding approximately with the present axis of Pearson Creek valley. Routing Pearson Creek through this depression to its original point of discharge into the Tongue River Reservoir at the conclusion of mining would prevent probable erosion in the lower reach of the Spring Creek channel by the combined flows of Spring and Pearson Creeks.
5. Use of riprap to prevent wave erosion on the access road and railroad embankments in the East Decker area and along relocated Route FAS 314 in the North Extension area.
6. Install culverts beneath relocated Route FAS 314 of sufficient size that no constriction is imposed on the channel of Spring Creek where it crosses the highway. Similarly, no constriction should be imposed at the Pearson Creek crossing, should that stream not be made a permanent tributary of Spring Creek. Erosion could be minimized by construction of these crossings during the period of low stream flow. Care should be exercised

during construction to exclude construction debris such as oil and asphalt from these water courses.

Sediment yield to the Tongue River Reservoir could be reduced dramatically by proper application of the foregoing mitigating measures coupled with those measures proposed by the Decker Coal Co. Construction of stable channels over the highwall would prevent dissection of the valley floors upstream. In that event, the excessive sediment yields to the Tongue River Reservoir of as much as a thousand acre-feet from the East Decker area (p. 354) and several thousand acre-feet from the North Extension area (p. 417) would not occur. Instead it is estimated that use of the combined measures would reduce sediment yield to the reservoir to below premining rates. Sediment yields from watersheds that traverse the East Decker and North Extension areas should be reduced by at least 50 percent (18-25 acre-feet annually) during mining and by at least 25 percent (10-20 acre-feet annually) after mining. Moreover, the reduction in sediment yield to the reservoir would be long term, probably lasting more than a hundred years, provided that the channels over the highwall remain stable. Aggradation in the flattened valley reaches downstream would progressively decrease with time as stable channels evolve through natural geomorphic processes. Eventually the sediment yield to the reservoir would return to approximately the premining rate.

(c) Replacement of surface-water supplies

It may not be necessary to mitigate the loss of surface-water supplies for livestock and wildlife in the East Decker and North Extension areas. Because of the lower surface and consequent flatter valley slopes in the reclaimed haul-road depressions that would carry runoff from the Middle Creek and Coal Creek watersheds, it is probable that runoff would collect in channel depressions the same as is presently occurring in the premining channels. Fine-grained sediments in transport would soon seal the channel bed, essentially recreating premining conditions. If necessary, water suitable for livestock and wildlife could be obtained from shallow wells at a depth of less than 50 feet.

Removal of the Tongue River mine lake and the nearby spring in the bottom of South Fork Spring Creek valley should be offset by postmining ground-water discharge in these same areas. Very probably, because of the lower land surface, Spring Creek in this reach would become a perennial stream fed by ground-water flow. If necessary, however, water suitable for livestock and wildlife could be obtained from very shallow wells at depths of less than 25 feet.

c. An enlarged Tongue River Reservoir

(1) Proposals of the Decker Coal Co.

The mine and reclamation plans submitted for approval by the Decker Coal Co. for the East Decker and North Extension mines do not address the impacts to the proposed operations and vice versa that would result from construction of an enlarged Tongue River Reservoir and impoundment of water to the higher spillway level. Accordingly, the plans submitted contain no proposed mitigations for such impacts.

(2) Possible mitigating measures

All impacts to the proposed mining operations attributable to construction of a stage I or stage II dam could be mitigated by delaying either dam construction or the impoundment of water in an enlarged reservoir to a level significantly higher than that of the existing reservoir spillway until after mining is completed. If water is impounded to spillway level of a stage I dam, flooding of the mine area and plant facilities in the East Decker area and the mine area in the North Extension area could be prevented by earthen dikes. Erosion by wave action of these protective dikes and of the access road and railroad-fill embankments in the East Decker area and the relocated Route FAS 314 roadway in the North Extension area could be prevented by appropriate riprap facings. Submergence and flooding of about two miles of the relocated Route FAS 314 roadway at stage I spillway level (3,438 feet) could be prevented by constructing the roadway so that the road surface would have a minimum elevation of about 3,450 feet. Construction of compacted-fill ground-water barriers (p. 538) would prevent increased ground-water inflow from the enlarged reservoir to the active pits. Completion of a stage II dam and impoundment of water to an elevation of 3,453 feet prior to completion of all mining activities in the impacted area is not currently regarded as a viable proposal. Accordingly, no mitigating measures are proposed.

Erosion by wave action of existing roadways or reclaimed spoil slopes resulting from completion of an enlarged reservoir after the completion of mining operations could be prevented by appropriate riprap protection. Because of the dilution afforded by the larger reservoir contents, deterioration of reservoir water quality as a result of added leaching in the reclaimed mine areas probably would not be measurable and, therefore, would not require mitigation. Construction of a stage II dam would probably require a second relocation of Route FAS 314.

4. Air quality

a. Compliance with existing regulations

The proposed East Decker and North Extension operations would be subject to both Federal and State air-quality laws. Federal air-quality standards have been established by the U.S. Environmental Protection Agency (EPA); State standards have been established by the Air Quality Bureau of the Montana Department of Health and Environmental Sciences. Ambient air-quality standards are given in tables 5 and 6.

The Decker area has recently been designated by the EPA[1/] as an Air Quality Maintenance Area. That designation means that either violations of air-quality standards have been recorded or that growth projections indicate possible violation levels by 1985. To bring the Decker area into compliance as an Air Quality Maintenance Area, the Montana Department of Health and Environmental Sciences must implement actions to reduce particulate concentrations to below the Federal secondary standard for particulates (table 6). Accordingly, the following calculation shows that particulate concentrations must be reduced at the existing Morton hi-vol station (p. 108 and fig. 69A) by approximately 17 percent.

Given: An annual geometric mean for TSP of 70 ug/m^3 at the Morton station for 1976 and a Federal secondary standard annual geometric mean for TSP of 60 ug/m^3

Then:

$$\frac{70\ ug/m^3 - 60\ ug/m^3}{60\ ug/m^3} \times 100\% = 17\%$$

[1/] See Federal Register, vol. 41, no. 86, Monday, May 3, 1976.

Montana's Clean Air Act (Chapter 39, Title 69, R.C.M. 1947) requires that all new equipment that might provide a source of air pollution be equipped with maximum control capability in keeping with the most advanced state of the art. Pursuant to the Clean Air Act, the Department of Health and Environmental Sciences requires that a construction permit be issued prior to the erection of any coal-processing facilities (Montana Administrative Code 16-2.14(1)-S1400). Adopted rules also require that an operating permit be issued after such facilities are completed.

Records show that, owing to an oversight, apparently no construction permit was issued to the Decker Coal Co. for erection of their West Decker coal-loadout facility. The Company is required to obtain an operation permit for this facility, however, and such a permit is currently being processed by the Department of Health and Environmental Sciences. A construction permit must be obtained before work begins on the East Decker loadout facility. The Decker Coal Co. has recently applied for such a permit.

Regulations adopted pursuant to the Clean Air Act require that all reasonable measures must be applied to prevent particulate matter from becoming air borne during the storage, handling, and transporting of coal and from wind erosion on open areas within the mine boundary. In addition, regulations adopted pursuant to the Montana Strip and Underground Mine Reclamation Act require that "all appropriate methods shall be employed by the operator to prevent loss of haulage or access road surface material in the form of dust."

Visible emissions from existing point sources are limited by Montana regulations to 40 percent visible opacity whereas emissions from new sources are limited to 20 percent visible opacity. In addition, New Source Performance Standards proposed by EPA on October 24, 1974, for coal-preparation plants require that emissions from coal-processing and conveying equipment, coal-storage and transfer systems, and loadout facilities must meet a 20 percent opacity standard (U.S. Environmental Protection Agency, 1974).

Should the Decker Coal Co. fail to observe all regulations and standards relating to the prevention of air-quality degradation, they would face possible fines and/or permit revocation. Initial indication of non-compliance would be in the form of notices of violation issued by the Montana Department of Health and Environmental Sciences (see p. 114).

b. Proposals of the Decker Coal Co.

Mitigation measures for controlling air pollution at the proposed East Decker and North Extension mines are aimed primarily at the control of fugitive dust and other particulate matter. Fugitive-dust emissions generated from topsoil and overburden removal, coal mining and processing, coal handling, and haulage traffic would require some abatement and preventative measures to maintain safe dust-exposure levels for mine personnel. For employee safety, dust-exposure levels for all personnel would be monitored at appropriate intervals and locations.

Mobile spray equipment, including 8,000-gallon tank trucks, would be used to suppress dust in areas of mining activity and on haul roads. Water would be obtained from mine effluent or impoundments within the mine areas. Other methods of dust control on roads include surfacing haul roads with crushed clinker and paving access roads. Dust-control equipment would be attached to drill rigs to reduce dust generated during drilling operations.

To control dust emissions during coal processing, crushers and conveyors at both the existing West Decker mine and the proposed East Decker mine would be enclosed. Dust emissions from coal stock piles would be reduced by storing processed coal in concrete silos prior to shipping. In addition, the possibility of installing dust-suppression equipment on railroad and truck-dump loadout areas is being investigated by companies that manufacture this type of equipment.

Reclamation and revegetation would progress in coordination with mining activities, thereby reducing dust emissions from spoil piles and other disturbed areas. Removal of topsoil in advance of overburden and coal extraction would be carefully scheduled to meet coal-production requirements, thereby eliminating unnecessary surface disturbance.

The Decker Coal Co. proposes the following actions to reduce the buildup of gaseous emissions in the mine and plant areas:

1. Engine idling during periods of mine equipment inactivity would be monitored and reduced where possible.
2. Ventilation fans and a methane-monitoring program have been installed in the West Decker coal-storage silos and would be installed in the coal silos at the proposed East Decker mine.

To adequately monitor particulate concentrations in the East Decker and North Extension areas, the Decker Coal Co. has agreed to install and operate seven hi-vol air-sampling devices at locations selected by the Montana Department of Health and Environmental Sciences. The proposed air-quality monitoring program is described in section IV. B. 6. b.

c. Other possible mitigating measures

The installation of dry dust collectors (fabric filters) on the ventilation exhaust from the crusher complex is another possible mitigation measure. Such collectors are suggested in keeping with the EPA proposed New Source Performance Standards for coalpreparation plants of 20 percent visible opacity. An alternate method of control is water or chem-jet dust-suppression sprayers; however, problems of freezing and added moisture could result. Emissions from the storage silos could be controlled by venting the emissions through a fabric filter. A flexible loading sleeve could be used during railroad-car loadout operations to reduce dust emissions. Wind-blown dust from railroad cars in transit could be controlled by spraying the surface of the coal in each car with an organic sealant or oil film, if necessary.

Atmospheric emissions associated with blasting would be inevitable and could be mitigated only to a small degree. Water sprays and sequential blasting should be employed whenever and wherever feasible to reduce the amounts of fugitive dust. Blasting activities, however, would be intermittent and of short duration and are not foreseen as producing a significant environmental impact.

Water sprays with or without chemical additives may be necessary to control dust from the drilling rigs. When necessary to minimize dust emissions during hauling and loading, the haulage equipment should be washed or wetted down. Water-spray application rates should be kept to the minimum necessary to control dust emissions and prevent unnecessary runoff and sheet erosion.

Alternatives to the water-application methods would be to shield the overburden and coal-storage piles from wind erosion by construction of wind fences and berms. Another method that has achieved some success would be to spray the piles with a water-soluble organic polymer, which forms a hard surface that reduces wind-blown dust. Dust-control strategies, such as limiting soil disturbances to the minimum area necessary and revegetating disturbed areas as soon as possible, would be beneficial in controlling fugitive dust.

To control vehicular-generated dust within the proposed mine areas, vehicle speeds should be restricted to the minimum necessary for economical mining operations. Vehicles or equipment using internal-combustion engines should be equipped with air-pollution-control devices that control particulate and gaseous exhaust emissions. Periodic maintenance and tuneups of vehicles and equipment are also helpful in emissions reduction.

No effective emission controls for diesel locomotives are available; therefore, emissions from train operations cannot be avoided. The major suppliers of diesel locomotives are now conducting a major research and development program to reduce both visible emissions and exhaust gas contaminants on future production engines. They are also developing retrofit components for existing engines (VTN Colorado, 1975a, 1975b).

Additional suggestions for reducing particulate emissions in the Decker area include (1) shortening haul roads wherever possible, (2) increased haul-road watering, and (3) reduction in coal production at the West Decker mine below 1976 levels (David Maughan, Montana Department of Health and Environmental Sciences, Air Quality Bureau, written communication, January 17, 1977). In fact, a decrease in the monthly coal production rate at the West Decker mine below levels reported during the last half of 1976 should occur when production begins at the proposed East Decker and North Extension mines.

5. Vegetation

a. Proposals of the Decker Coal Co.

The Montana Strip and Underground Mine Reclamation Act requires that strip-mined areas be reclaimed to a "permanent, diverse cover capable of regenerating under natural conditions and able to withstand grazing pressure comparable to that prior to strip mining" (Section 50-1045, R.C.M. 1947).

In addition, the rules and regulations adopted pursuant to the Reclamation Act require that the species planted on retopsoiled areas must be dominantly native. Following mining, the long-range productivity of the East Decker and North Extension areas would be dependent on successful mine-site reclamation.

In accordance with the Reclamation Act, retopsoiled areas would be seeded with a mixture of primarily native grasses, shrubs, and forbs that approximates the existing vegetation composition. Seeding rates (see p. 40) have been chosen that approximate the frequency of occurrence of native species in the Decker area as well as the expected reestablishment success of planted species. Seeding would be done with a seed drill. All the seed used would be locally grown and genotypical whenever available and would be at least 90 percent pure. The following seed mixture is proposed for the East Decker and North Extension sites:

Species	lbs/acre
Western wheatgrass	4
Thickspike wheatgrass	3
Slender wheatgrass	3
Whitmar wheatgrass	4
Green needlegrass	4
Prairie sandreed	3

Species	lbs/acre
Blue grama grass	1
Pubescent wheatgrass	2
Smooth brome grass	2
Ladak alfalfa or Remont sainfoin	½
White prairie clover	½
Four-wing saltbush or nuttal saltbush	1

In addition to the above seeding mixture, small amounts of big sagebrush, skunkbrush sumac, little bluestem, sideoats grama, ponderosa pine, mountain juniper, and western chokecherry would be planted on suitable sites. Such species would promote the maintenance of premining ecosystem diversity. Shrub and tree species would be planted by hand using young plants.

In drainage ways, four pounds per acre (pure live seed) of Tegmar wheatgrass would be substituted for Whitmar wheatgrass. Tegmar wheatgrass is a rhizomatous, soilbinding grass variety recommended by the Soil Conservation Service for waterway stabilization.

Foraging in reseeded areas by rodents and other small mammals is a problem of undetermined magnitude. Coal company reports as well as observations by the Montana Department of State Lands personnel are inconclusive as to the impact of such foraging on revegetation success.

To further promote successful revegetation of retopsoiled areas, the Decker Coal Co. has proposed the following:

1. Seeding retopsoiled areas only during April and/or October-November; the months when the chances for successful establishment are the greatest.

2. Initially fertilize all seeded areas using 300 lbs/acre (16-30-0) to assist in seedling establishment.
3. Utilize mulching and sprinkler irrigation as necessary to further assure seedling establishment.
4. Fence reseeded areas for a period of time to allow proper establishment before grazing is allowed.
5. Continuously monitor reclamation areas by qualified company specialists.

The reader is referred to section IV. B. 2 for additional discussion of measures that could be used to mitigate impacts from soil disturbances caused by surface mining. Such measures are also important to the re-establishment of a suitable plant cover.

b. Other possible mitigating measures

Because the A soil horizon is the principal zone of organic material accumulation and biological activity, this horizon is of primary importance as a vegetation growth media. When the A horizon is stripped, it becomes diluted with other "salvable" topsoil. For example, when the A horizon is 6 inches thick and the total topsoil salvage depth is 5 feet, a dilution of about 10 to 1 would occur. In the replacement of topsoil on spoil surfaces, materials from the A horizon could end up near the base of the replaced soil layer and, thus, be virtually lost to the process of revegetation.

It is generally impractical to remove and handle the A horizon separately in the Decker area, but it may be generally feasible to remove and handle the combined A and B horizons. To prevent excessive dilution of the A horizon, therefore, separate salvaging and handling of the combined A and B horizons and the immediate reapplication of this material as the uppermost soil layer on regraded surfaces is suggested. This practice, together with supplemental seeding, would likely result in better and more rapid revegetation of the two proposed mine areas.

To find ways to mitigate vegetation impacts, the Montana Department of State Lands encourages revegetation research on mine spoils. No bond on research areas would be released, however, until the Decker Coal Co. satisfactorily meets the reclamation criteria included in the Montana Strip and Underground Mine Reclamation Act and the rules and regulations adopted pursuant to that act. The capability of replaced soils in the West Decker mine area to recover and support native vegetation has been debated and has led to the implementation of several research projects. Findings from these studies might be beneficial in reestablishing a permanent, diverse vegetative cover on the proposed East Decker and North Extension areas as well.

The Montana Agricultural Experiment Station began research efforts at the West Decker mine during the summer of 1973 and recently summarized their findings as follows (Montana Agricultural Experiment Station, 1975).

1. "Of 1971 seeding attempts, only a limited number of species were capable of establishing themselves successfully with 10-15 centimeters of topsoil over spoil materials. Wheatgrasses, several legumes and greasewood were the most successful species. Summer-cypress and annual saltbush invaded the plots. The failure of the species to become established was attributed to a combination of saline-alkali soil, drought conditions, and relatively poor site preparation."

2. "Varieties of crested wheatgrass demonstrated favorable establishment at the mine."

3. "In a scoria shrub seeding study four-wing saltbush and greasewood responded better than twelve other shrub species seeded."

4. "Seeding areas spoils with seven different annual grasses was not effective in stabilizing spoil slopes."

The U.S. Forest Service has also established research plots in the West Decker mine area. In reporting their first-year results, Farmer, et. al., (1974) report that:

1. "There are no indications that the raw overburden material had any adverse effects on either seed germination or seedling emergence. Seedling counts early in the growing season showed plentiful vegetation on all subplots. This result is partially attributed to thorough seedbed preparation and packing the seedbed after sowing."

2. "On the basis of dry-weight production, several treatments yielded grass stands capable of adequately protecting the spoil material against either water or wind erosion. The greatest yields were on irrigated subplots that were both fertilized and mulched. However, this treatment cannot as yet be recommended for two reasons: (1) continued irrigation with the present water supply will probably create strongly adverse soil conditions that will require correction, and (2) there is no information as yet on the consequences of stopping irrigation. These limitations also apply to irrigated plots that were fertilized but not mulched. The unfertilized irrigated subplots yielded rather poor stands and do not, at this time, appear to offer a desirable alternative."

3. "All of the subplots located on the top-dressed soil yielded acceptable stands. Fertilization had some positive effect, though not as large as expected. The principal objection to top-dressing aside from cost considerations, will probably be the presence of weed seeds in the topsoil. On the average, over the entire top-dressed plot, only 47 percent of the total yield was in desirable grass species; the rest was in weeds, principally summer cypress (_Kochia scoparia_), Russian thistle (_Salsola kali_), and Japanese brome (_Bromus japonicus_). If top-dressing is practiced, some type of weed control program seems desirable. Generally, the control plots did not produce adequate grass stands in the first year. An exception may be the control plots that are both fertilized and mulched, but these plots are only marginally acceptable."

4. ..."Except for the irrigated plots that were mulched and fertilized, the top-dressed plots generally yielded the greatest grass weights. According to these first year results the top-dressing of mine overburden, regardless of mulch or fertilizer, appears to be a highly desirable revegetation practice."

5. "In each seed mixture the wheatgrasses dominated the dry-weight production. Generally, wheatgrass seedlings were identified only as Agropyron spp. However, the slender wheatgrass plants were exceptionally vigorous and many produced seed in the first growing season. Smooth brome was a notable component of both the introduced and native-introduced grass mixtures, but usually did not set seed. More complete species information will be collected as the study progresses."

To date, the Montana Agricultural Experiment Station and U.S. Forest Service revegetation studies at the West Decker mine site have yielded variable results. Differences may be partly attributable to variations in the chemical and physical characteristics of the overburden and soils.

The time elapsed since reclamation efforts began at the West Decker mine site is insufficient to permit conclusive statements regarding the reclaimability of the area. Time and additional reclamation research will prove or disprove whether reclamation, consistent with the Montana Strip and Underground Mine Reclamation Act, is ultimately achievable at both the West Decker and the proposed new mine areas.

6. Environmental monitoring

After approval of the mining plan, the Area Mining Supervisor of the U.S. Geological Survey must make on-site inspections at least four times a year to assure compliance with lease terms, regulations, and the approved mining plan (see p. 11). The District Manager of the Bureau of Land Management also must make compliance checks to assure that surface disturbances are not excessive. The operator is required to report, as soon as possible, to the Area Mining Supervisor, U.S. Geological Survey, any environmentally degrading accident or any failure of the approved plan to function as expected.

In addition to the above Federal rules, rules and regulations adopted pursuant to the Montana Strip and Underground Mine Reclamation Act require that:

1. Hydrologic data necessary to monitor water quality and quantity must be made available by the Decker Coal Co. on request by the Department of State Lands.
2. All approved and constructed treatment facilities must be maintained in proper working order by the Decker Coal Co. and must be monitored by the company to assure continuous satisfactory performance until approved reclamation has been accomplished.
3. Monthly monitoring reports, where applicable, must be submitted to the Department of State Lands giving the number of operating days, the gallons of drainage treated, a log of the tests made in accordance with statutory regulations, and a description of any operating problems and the corrective action taken.
4. The Department of State Lands must inspect seeded areas annually at the end of the growing season. If the department determines that seedings are unsuccessful, immediate investigative action must be taken by the company so that alternatives can be employed to establish the desired permanent vegetative cover at the very next seasonal opportunity.

Because of the minimal reference to existing and proposed monitoring programs in the mining and reclamation plans submitted for approval by the Decker Coal Co., the Environmental Coordinator of that company was asked to submit more complete information. His reply was in the form of brief memorandum reports prepared by the various responsible company personnel. Copies of those memorandums are included in Appendix J. Information on monitoring was also received in the form of a written communication from David Maughan of the Montana Department of Health and Environmental Sciences, Air Quality Bureau. Proposed and ongoing monitoring activities are summarized as follows:

a. Climate

A weather station is currently being installed by the Decker Coal Co. near the plant area at the West Decker mine. Continuous records of precipitation, temperature, wind speed and direction, relative humidity, barometric pressure, evaporation, and solar radiation will be obtained by company personnel for as long as the Decker Coal Co. is active in this general area.

The Montana Department of Health and Environmental Sciences, Air Quality Bureau recommended that: (1) The present wind-monitoring device should be raised to a level 10 meters higher than adjacent hills or buildings; (2) wind and precipitation data should be forwarded to the Air Quality Bureau on a monthly basis; and (3) climatic monitoring devices should be properly maintained.

b. Air quality

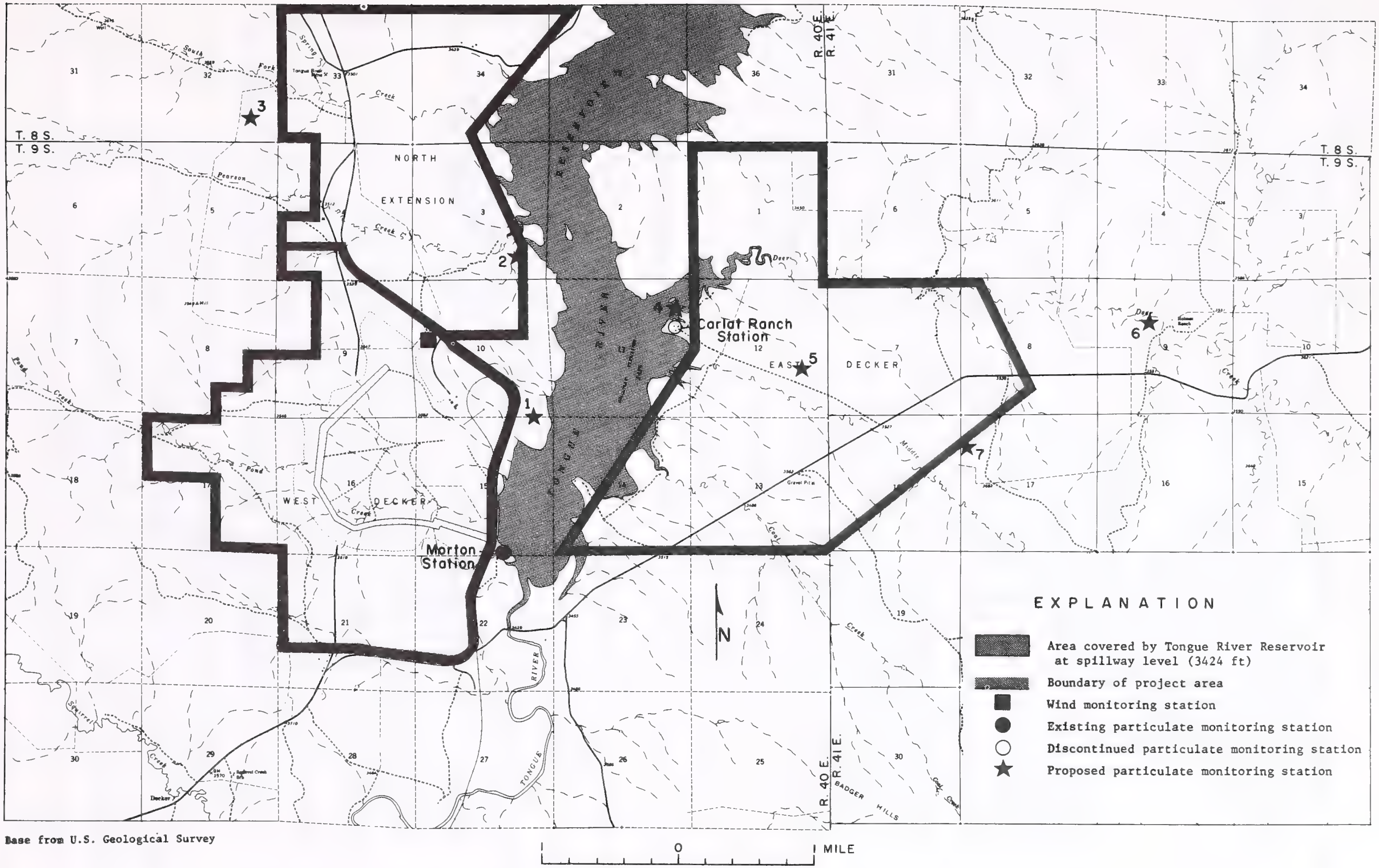
Two high-volume samplers are proposed for monitoring air-borne particulate matter in the Decker area. These samplers would be located so as to adequately sample air quality in both the proposed East Decker and North Extension operations.

The Decker Coal Co. has agreed to install and operate seven hi-vol air-sampling devices for monitoring particulates at locations selected by the Air Quality Bureau. The location of these proposed particulate monitoring sites together with the location of existing and discontinued sites are shown on figure 69A. The Air Quality Bureau emphasizes that total suspended particulate sampling at these stations must comply with the reference sampling procedure described in the Federal Register, vol. 36, no. 84, Friday, April 30, 1971. Such sampling is subject ot State audits on operation, calibration, and data handling. In addition, the Air Quality Bureau recommends that (1) TSP data should be submitted to the Air Quality Bureau on a monthly basis and (2) the duration of TSP sampling should extend for two years after the beginning of the proposed East Decker and North Extension mining operations. At the end of two years, a reevaluation of TSP levels in the Decker area would be made by the Air Quality Bureau. That reevaluation would be similar to the procedure described in section II. A. 5.

c. Soils

Detailed soil analyses establishing baseline conditions have been made by the Decker Coal Co., and soil maps have been completed for the East Decker and North Extension areas (section II. A. 7.). Research, involving soil testing and monitoring in the Decker area by the U.S. Forest Service and by Montana State University, is currently in progress under contract with the Decker Coal Co. Results of this research should be applicable to the proposed mining operations.

Detailed soil analyses (see p. 29) would be made by the Decker Coal Co. before, during, and after all soil disturbances. Soils would be tested



Base from U.S. Geological Survey

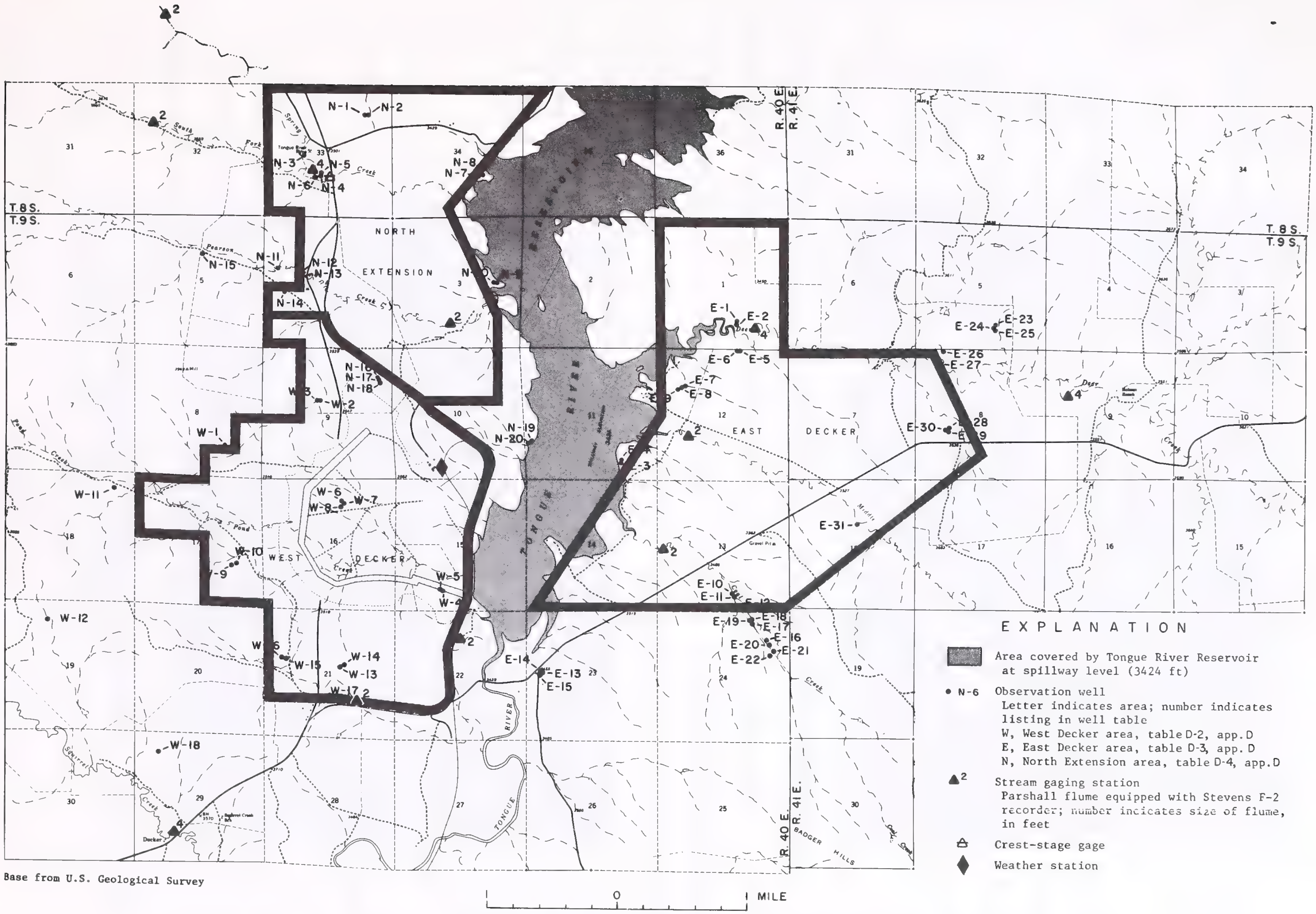
Figure 69A. – Map showing location of air-quality monitoring network in the Decker area.

before stripping, after stockpiling, and again after spreading and prior to revegetation. Periodic soil analyses are tentatively planned in revegetated areas to note any temporal changes.

d. Hydrology

(1) Ground water

A total of 69 observation wells have been constructed in the Decker area by the Decker Coal Co. and the Montana Bureau of Mines (fig. 70). They include 18 wells in the West Decker area (table D-2, Appendix D), 31 wells in the East Decker area (table D-3, Appendix D), and 20 wells in the North Extension area (table D-4, Appendix D). Most of these wells are equipped with shelters (fig. 71) and can readily be monitored for selected periods by installing recording equipment. To complete the monitoring network three additional monitoring wells would be drilled into the clinker in the SW¼ sec. 34, T. 8 S., R. 40 E. One of these wells and one each of the existing wells completed in alluvium in the Tongue River, Deer Creek, and Spring Creek valleys would be instrumented with Stevens F-2 stage-recording gages. In addition, at least one well completed in each of the coal beds would be monitored until final bond release. Tentative plans call for monitoring of water levels and water quality to be continued by the Montana Bureau of Mines under contract with the Decker Coal Co. Should monitoring by the Montana Bureau of Mines be discontinued for any reason, however, observations would be continued by personnel of the Decker Coal Co. Water-level measurements would be made at least bimonthly. Water samples would be collected annually from wells tapping confined aquifers and semiannually from wells tapping unconfined aquifers. These samples would be analyzed according to procedures and standards established by the State of Montana.


EXPLANATION
▨ Area covered by Tongue River Reservoir at spillway level (3424 ft)
● N-6 Observation well
Letter indicates area; number indicates listing in well table
W, West Decker area, table D-2, app. D
E, East Decker area, table D-3, app. D
N, North Extension area, table D-4, app. D
▲2 Stream gaging station
Parshall flume equipped with Stevens F-2 recorder; number indicates size of flume, in feet
△ Crest-stage gage
◆ Weather station
NORTH EXTENSION
WEST DECKER
EAST DECKER
TONGUE RIVER RESERVOIR
TONGUE RIVER
T.8S.
T.9S.
R.40E.
R.41E.
BADGER HILLS
Decker
0
1 MILE

Base from U.S. Geological Survey

Figure 70.– Map showing location of hydrologic monitoring network in the Decker area.

Measurements of virtually all existing wells and springs in the Decker area by the U.S Geological Survey (tables D-1 and D-5, Appendix D) provide baseline data against which to measure future changes.

(2) Surface water

Stream gaging stations, consisting of Parshall flumes equipped with Stevens F-2 stage recorders (fig. 72) and crest-stage gages, are currently operated by the Decker Coal Co. on all principal streams that traverse the East Decker and North Extension areas. Flumes having a throat width of 2 feet that are capable of measuring discharges ranging from 0.7 to 33 ft^3/s are maintained on both Spring and South Fork Spring Creeks upstream from the North Extension area and on Pearson, Middle, and Coal Creeks near their mouths. Flumes having a throat width of 4 feet that are capable of measuring discharges ranging from 13 to 68 ft^3/s are maintained on the main channel downstream from the junction of Spring Creek and South Fork Spring Creek (fig. 70) and at two locations on Deer Creek, one near its mouth and one upstream from the East Decker area. These recording gages will be operated continuously at their present locations until the proposed mining plans are implemented.

After channel diversions are completed, gaging stations located near the mouths of the diverted streams would be relocated near the outlets of the diversion channels. These stations would be operated by the Company until all applicable reclamation bonds are released--approximately five years after cessation of mining operations. In addition, flumes equipped with recording gages would be installed on all mine-effluent settling ponds and the outflow monitored, as required by State law.

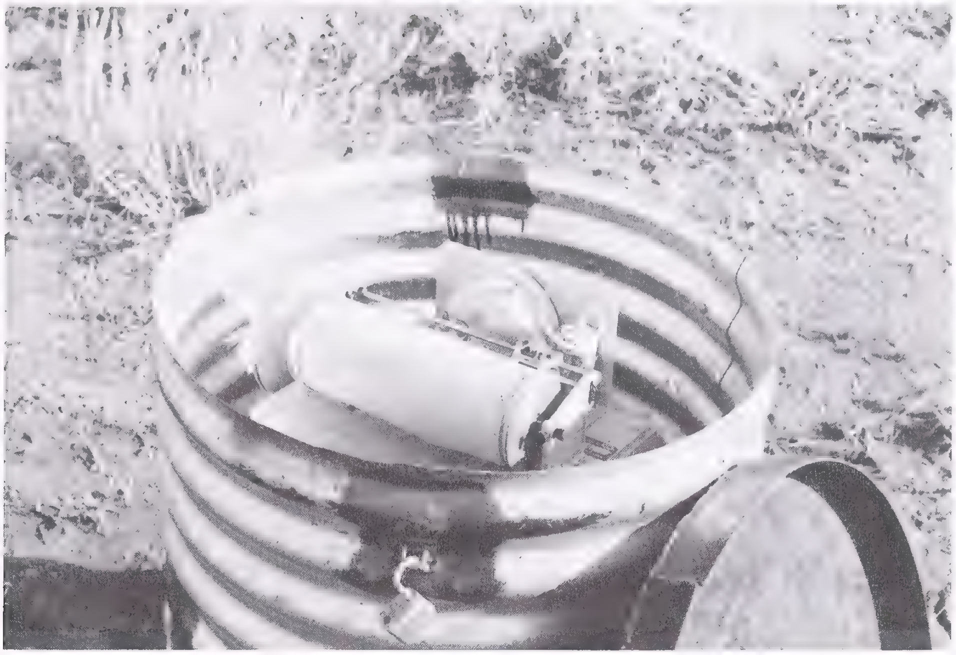


Figure 71.-Observation well equipped with shelter and water-level recorder.

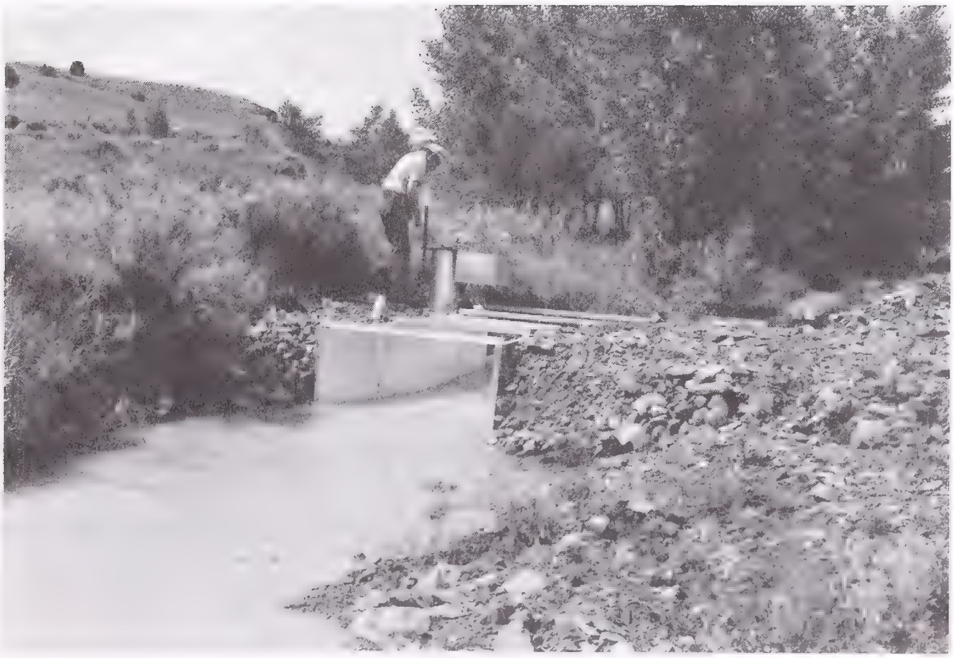


Figure 72.-Stream gaging station on Spring Creek. Parshall flume equipped with Stevens F-2 stage recorder is capable of measuring discharges ranging from 1.3 to 68 cubic feet per second.

Representative water samples for chemical analysis according to procedures and standards established by the State of Montana are currently being collected annually at each of the operating stations during high flow, intermediate flow, and low flow. Tentative plans are to install sediment sampling devices at all gaging stations prior to the 1976 spring runoff period. Sediment samples would be analyzed using the same procedures as those used for testing soil samples. Water-quality monitoring would be continued by the Decker Coal Co. until the release of all applicable reclamation bonds.

The U.S. Geological Survey expects to continue operation of the gaging station on the Tongue River near the State line (p. 191) and the station downstream from the Tongue River Dam throughout the period of coal development in the Decker area. The crest-stage gage on Spring Creek at Route FAS 314 (p. 196) will probably be maintained until the diversion of Spring Creek is completed.

e. Vegetation

Numerous permanent vegetation transects have been established in the East Decker and North Extension areas by Decker Coal Co. personnel in conjunction with the collection of baseline data on the plant cover in these areas. Canopy coverage and the standing crop were measured along these transects. Phytograms depicting clump intercept were prepared for the first hundred feet of selected transects and are proposed for all remaining undisturbed transects. Monitoring would consist of repeat measurements of canopy coverage and phytogrametric comparisons of the plant cover along transects reestablished at approximately the same location as before mining. Phyto-social changes on the reclaimed surface would be monitored, if desired, by repeating measurements annually until reclamation bonds are released. Standing-crop sampling would be conducted during the two years prior to bond release to obtain quantitative comparisons of vegetation production before and after mining.

f. Wildlife

The following monitoring of wildlife is or would be conducted by personnel of the Decker Coal Co. unless indicated otherwise.

(1) Big game

Aerial transects are monitored monthly and supplemented by random field observations to determine changes in population and distribution patterns for mule deer, white-tailed deer, and antelope. Daily telemetry observations using radio-tagging methods are made of 30 mule deer in the East Decker, West Decker, and CX Ranch areas. The CX Ranch area borders the West Decker and North Extension areas on the west side. Seasonal measurements are made along browse transects to determine the use of big-game winter foods.

(2) Small game

Random field observations are made to determine changes in population and distribution patterns for sage grouse, sharp-tailed grouse, Hungarian partridge, and ring-necked pheasant. The use of strutting and dancing grounds are checked at least three times each week during mating activity. Intensive studies are currently under way to mark sage grouse and monitor their movements to define wintering areas, resting areas, brood-rearing areas, and population structures.

(3) Small mammals

Species diversity, density, production, and home-range requirements are monitored monthly during appropriate seasons in 12 study areas using live-trapping methods. Similar measurements would be made in reclaimed areas after mining to provide comparative data. Monitoring also would provide information on egress from and ingress to the disturbed and reclaimed areas. Simultaneous vegetation measurements would be made to determine any relationships between small mammal populations and vegetation production.

(4) Nongame birds

Breeding-bird densities would be monitored annually in areas of natural habitat and in reclaimed areas.

(5) Fisheries

Baselines studies of the limnology of the Tongue River Reservoir would be continued through 1976. Thereafter, monthly measurements would be made to detect any limnologic changes. Annual sampling of the game and nongame fisheries in the Tongue River Reservoir would be conducted by the Montana Department of Fish and Game.

C. Mitigating measures to impacts extending outside the proposed mine areas

1. Wildlife habitat

a. Birds and mammals

Timely restoration of habitat lost through the process of strip mining is the most effective method of mitigating the impacts on wildlife species. By carefully assessing wildlife needs prior to reclamation efforts and by implementing sound reclamation procedures, impacts on wildlife due to habitat losses at the two mine sites may be minimized. Specific mitigations proposed by the Decker Coal Co. include (VTN Colorado, 1975a, 1975b):

(1) Several browse and forb species (see p. 571) utilized by wildlife species as food and cover would be seeded or planted on retopsoiled areas.

(2) All fences would be built to specifications that would not prevent field movement of wildlife or increase accidental losses.

(3) Human activity in areas not being mined would be kept to a minimum.

(4) Through planned reclamation procedures, an attempt would be made to reestablish sharp-tailed grouse habitat.

(5) Before mining destroys the sage grouse strutting ground in the East Decker area, efforts would be made to relocate this site or to encourage these birds to use other active strutting grounds in the area.

Other possible mitigating measures that could be used are as follows:

(1) Additional shrub species valuable to wildlife (i.e., winterfat and rubber rabbitbrush) should be planted on revegetated areas.

(2) Access should be limited in areas of known sage grouse use, and no activity should be allowed around active strutting grounds prior to and after mining (VTN Colorado, 1975a, 1975b).

(3) Specially selected areas should be planted to heavy stands of big sagebrush in an effort to provide feeding, wintering, and nesting areas for sage grouse on revegetated areas (VTN Colorado, 1975a, 1975b).

(4) Tree growth should be encouraged to provide nesting sites for raptors (Olendorff and Stoddart 1973).

(5) All human activity in the vicinity of the heron, cormorant, and waterfowl nesting areas should be minimized to reduce stress on these species (VTN Colorado, 1975a, 1975b).

(6) Reclamation of disturbed areas would alleviate impacts on song birds by restoring some nesting and feeding areas. Any ground or vegetation disturbance (i.e., removing topsoil, building roads, etc.) should take place after young birds have been reared and have left the nest.

Potential problems exist with respect to successful reclamation for wildlife because the specific habitat requirements for many species are only partially understood. Wildlife habitat is related to animal behavior, which man cannot manage. Therefore, even though man's attempts at duplicating premining conditions are termed successful, animals may not use the reclaimed areas because one minor interacting factor is lacking.

Other problems with respect to the reclamation of wildlife habitat arise because present reclamation practices of Decker and other coal companies in Montana are not directed primarily towards wildlife needs. Instead, as a result of the grading requirements in the Montana Strip and Underground Mine Reclamation Act, lands better suited for use in raising livestock and monotypic grain crops are generally created when mine spoils are retopsoiled and reseeded.

Certain tree and shrub species important for use as wildlife food and cover are difficult to recreate on mine spoils. Ponderosa pine and Rocky

Mountain juniper, for example, typically grow on thin coarse-grained soils over sandstone. These coarse-grained soils provide the necessary soil-moisture conditions for these plant species. Other species important to wildlife may occur over hard pan areas and rely for survival on moisture perched on the hard pan layer. Both of these soil conditions would be destroyed by mining, and hence, the vegetation that grows in such areas would be difficult to reestablish.

b. Fish

Spoil materials should be tested for toxicity before being placed in contact with reservoir water. If these tests indicate that appreciable chemical and physical changes would take place in the reservoir, measures should be instigated to reduce overburden contact with the reservoir waters. This could be done by segregating potentially toxic material and using the best suited material for railroad fills or by using material other than overburden material for fills.

To reduce sediment loads discharged into the Tongue River Reservoir, all surface runoff and mine-water effluent would be diverted into settling ponds before entering the reservoir. Present predictions suggest that mine-water effluents would pose no problems with respect to treatment. This prediction stems from the fact that the volume of mine effluents would be so minor with respect to the volume of the reservoir that dilution should render the effluents undetectable.

2. Population (Fitzpatrick, 1975)

Population change in itself is not a phenomenon which necessitates either mitigation or encouragement. The demands and requirements of the population specify the type and degree of mitigating measures. Some locations are better able to absorb increasing population levels. Other areas lose little substance with declining numbers of people. A discussion of mitigating measures as they relate to population change is included in other sections dealing with social and economic analysis (sections IV. C. 4 and IV. C. 5).

3. Land use and community development

The adoption and rigid enforcement of land-use plans that discourage uncontrolled and scattered land development is the best mitigating measure to avoid undesirable changes in land use. Long-range plans have been proposed in Rosebud and Big Horn Counties, Montana, and are being developed for Sheridan County, Wyoming. For such plans to be effective in the socio-economic impact area, however, coordination among the three counties and cooperation of the mining industry would be necessary.

The following discussion focuses primarily on the city of Sheridan and on Sheridan countywide efforts to plan for expansion. To aid in the presentation of the various existing or proposed land-use and community-development proposals, the following discussion is divided into categories. The discussion under each category, however, often overlaps the material presented in adjacent divisions.

a. Existing regulations and regulating bodies

Big Horn and Rosebud Counties in Montana have each adopted county subdivision regulations and have proposed county land-control ordinances. In addition, these counties have created land-use planning boards.

Sheridan County in Wyoming also has subdivision regulations, which may be strengthened and supplemented by zoning ordinances adopted upon the recommendations of the Sheridan Area Planning Agency. The city of Sheridan has an active planning commission that has adopted zoning and subdivision regulations for land within the corporate limits of the city.

b. The Sheridan Area Planning Agency

The Sheridan Area Planning Agency (SAPA) was formed to conduct planning studies in the Sheridan area and is composed of representatives from the city of Sheridan, from Sheridan County, and from the towns of Ranchester, Dayton, Story, Big Horn, and Clearmont. SAPA primarily coordinates projects of regional importance, including major economic development efforts, drainage problems, water-resource development, and construction of major recreational facilities. In addition, SAPA may recommend needed zoning and subdivision regulations to the member county and municipal governments.

SAPA has assembled much of the technical data needed by member agencies to qualify for Federal planning and development assistance. These data are presented in reports on land use (Sheridan Area Planning Agency, 1976a, 1976b), housing (Sheridan Area Planning Agency, 1976c), population (Sheridan Area Planning Agency, 1976d), economics (Sheridan Area Planning Agency, 1976e), and county needs (Sheridan Area Planning Agency, 1976f). A preliminary draft of a comprehensive plan for the city of Sheridan has been completed, and the final report should be available in the near future (Sheridan Area Planning Agency, 1977).[1/]

[1/] Funds for SAPA were obtained in part from the following: The Wyoming land use Commission; Title 208 Areawide Waste Treatment Management funds administered by the U.S. Environmental Protection Agency; an Urban Planning Grant from the Department of Housing and Urban Development under provisions of Section 701 of the Housing Act of 1954, as amended; Shell Oil Co.; Decker Coal Co.; Goose Creek Products; the Concentrated Employment Training Act; Western Interstate Committee on Higher Education; the Old West Regional Commission; and local cities and towns.

SAPA will continue its study of development in Sheridan County in an attempt to coordinate growth so as to mitigate at least some of the consequent adverse impacts. Accordingly, SAPA will examine:

1. Short and long-term policies, administrative procedures, and legislative proposals that determine where growth should and should not occur.
2. The type, intensity, and timing of growth.
3. Studies, criteria, standards, and implementing procedures necessary to effectively guide and control major decisions concerning the location of growth.
4. Policies, procedures, and mechanisms necessary to coordinate land-use policies of the various governmental units with functional planning and available capitol investment strategies. Land-use policies would also be coordinated with the improvements necessary to facilitate achievement of land-use plans (Sheridan Area Planning Agency, 1976g).

c. Comprehensive plans

As part of their planning assistance duties, the Sheridan Area Planning Agency (SAPA) has been helping member agencies with the development of comprehensive plans. Plans for Clearmont and Ranchester have been published, and a preliminary draft of the plan for the city of Sheridan is available. Comprehensive plans for other communities in the county are at least in the draft stages. Comprehensive plans for Sheridan County communities and the studies on which these plans are based (Sheridan Area Planning Agency, 1976c, 1976d, 1976e and 1976f) provide much of the data necessary for the member county and municipal governments to qualify for various Federal aid programs.

d. Federal and state funding for community development in energy impacted areas

Utilizing the planning data collected by SAPA, the Sheridan County governing body and other governing bodies in the county have recently applied for a variety of Federal and State planning and development funds. A total of 42 projects have been proposed for Sheridan County and for selected communities within the county during fiscal years 1976 and 1977. At the time of this writing (March 8, 1977), funding for 34 of these projects has been approved (totaling $1,502,348); funding for 5 projects is pending (totaling $3,351,100) (Bernie Spielman, Economist, SAPA, written communication, March 4, 1977). Examples of approved projects include: Additional comprehensive planning, county-road improvements, parks, rehabilitation of housing, a center for the handicapped, and a community development grant for sewer and water connections. A complete listing of these projects and their status are given in Appendix G.

Recent changes in Federal legislation indicate that the Federal government may play a much more active role in the future in providing funding for energy-related planning and community-development needs. Changes in the Mineral Leasing Act (30 U.S.C.A. 201), for example, may prevent leasing for speculative purposes and may, therefore, provide a way for states like Montana and Wyoming to more accurately forecast and plan for mineral development.

Other examples of Federal recognition of energy-development problems are provided by the recent enactment of the Bureau of Land Management (BLM) Organic Act (P.L. 94-579, Federal Land Policy and Policing Act of 1976).

This Act increases a state's share of Federal mineral revenues from 37½ percent to 50 percent and authorizes the extension of loans to states and communities impacted by development of Federal minerals against future states' shares of mineral revenues.

The Department of Interior is currently drafting regulations for granting loans under the Organic Act. This funding would provide timely assistance to states and subdivisions so that community development as a result of mineral extraction on public lands will be equitable and efficient. (Western Governor's Regional Energy Policy Office, 1977). Top priority for such funding will be given to those states and their subdivisions that suffer the most severe impacts from increased mineral extraction activities.

Funding available for mineral-development impact loans is estimated by the Department of Interior to be (in millions of dollars):

	1975	1976	1976
	at 37½ percent		at 50 percent
Montana	4.8	4.5	11.3
Wyoming	33.4	34.8	74.7

As with most new programs, some inadequacies and other problems with these regulations can be expected. Housing, for example, has not traditionally been considered in Federal programs as a "public facility" and, thus, may not qualify for mineral-impact funding. In addition, if a state chooses to utilize such monies, Federal funding under other programs may not be granted.

e. Other measures

Federal aid to energy-impacted communities also might occur in the form of a Federal tax on all extractive-energy sources. This mitigating measure has been proposed by John Mc Williams, former President of the Sheridan Area Planning Agency (written communication, November 18, 1976).

The proposed tax should be applied to energy sources in a way that would avoid pricing inequities among competitive energy sources. The tax also should be sufficiently high to assure that adequate funds are generated to cover the costs of local and regional impacts created by development of energy sources, including those imbalances created by past developments. Such a fund could be administered by a Federal department or agency such as the Department of Interior or the Federal Energy Administration.

Elaborating on his proposal, Mc Williams states (written communication, November 18, 1976):

> "Local governments or agencies of impacted areas would have both individual and joint access to this fund; monies from which would be available as direct grants, low interest or interest-free loans, and long term entitlements to cover increased operating costs. Such a program of financial assistance would take into account the greater abilities of some communities (through increases in their tax base) to finance the local needs, and the lesser abilities of others (such as Sherdian County) which serve as "bedroom" communities to development outside their boundaries, and also the needs of all communities during the lag time between impact and an increase in the tax base.
>
> In other words, the Federal government would develop an equalization program to finance costs of impact: These costs would be internalized in the costs of all energy (as reclamation costs are now internalized for strip mining) and made available according to need. The size of the fund, like the amount of tax, will have to be developed by economists more skilled than I. But the principle will assure that everyone, in the National Interest, share the costs of developing energy for the National Interest."

Other mitigating measures for energy-related impacts could be funded by the states themselves. The Sheridan Area Planning Agency, for example, has identified several statutory mechanisms whereby Wyoming communities could help mitigate development-related impacts. Such measures include: The Wyoming Joint Powers Act, the Wyoming Community Development Authority, coal severance taxes, a 1-cent sales tax, bond issues, utility service charges, and property taxes. It is anticipated that the current Wyoming Legislature may enlarge, and perhaps adjust these statutory authorities to provide more assistance to communities like Sheridan.

In their consideration of a coal severance-tax increase, Wyoming might follow the example of the Montana legislature, which in 1975 recognized that the rate of coal taxation must be sufficient to (1) modestly increase general-fund revenue, (2) respond to the local economic and social impact of coal development, and (3) invest in a trust-fund legacy for the future when coal mining may decline (Himsl, 1975). Accordingly, the legislature passed a severance tax of up to 30 percent of the gross value of production as determined by the mine-mouth coal price. The taxes are allocated to the State general fund, to the various county general funds, and to eight other funds (e.g., highway improvement, education, county planning, etc.) according to a complex schedule (p. 525-526). In companion legislation, a coal board of seven members was established to administer local impact grants to governmental units.

4. Economics (Polzin, 1975)

The projected economic impacts of the proposed Decker mines cannot, for the most part, be classified as either "costs" or "benefits." That is, the same event might be interpreted by some as an improvement and by others as an adverse impact. In such cases, proposals for mitigating actions must be examined very carefully because of the possibility that a "benefit" to one group might result in a "cost" to another group. In the process, more problems may be created than are solved.

The proposed Decker mines would increase the demand for workers in the Sheridan area. Accordingly, existing employers may have to pay higher wages to retain employees or they may be unable to hire additional workers at existing pay scales. On the other hand, the increase in job availability may provide positions for the unemployed (both real and disguised), allow persons with only part-time jobs to move into full-time employment, and provide opportunities for low-wage workers to advance into higher paying positions. More attention would undoubtedly be centered on the new well-paid mining positions, but the new derivative jobs--the clerks, shopkeepers, and service personnel--should not be overlooked. Their jobs would generate quietly throughout the economy and would not be obviously associated with coal development. On the average, these workers would be lower paid than those holding mining positions, but they usually require less training. If historical patterns prevail, many of the derivative jobs would be filled by females and the young.

The increased population associated with the new mines would place an additional strain on the already tight housing market in the Sheridan area. Rents and property values would rise and adversely affect renters and persons seeking to build new homes. On the other hand, as a mitigating result, property owners would experience a capital gain; about 60 percent of the dwelling units in Sheridan County--66 percent in the city of Sheridan--are owner occupied (U.S. Department of Commerce, Bureau of Census, 1972).

5. Social structure and social services

a. Introduction (Institute for Social Research, 1975)

Impacts of the mine expansions on the social structure and social services as anticipated by the citizens of Sheridan are outlined in section III. C. 10. Nearly all mitigation measures for such impacts would cost money, and most respondents surveyed felt that these costs should be borne by those responsible for the impacts. Seventy-four percent of the Sheridan residents surveyed thought that an industry employing new families should pay part of the increased service costs; 58 percent thought that the coal industry and the States of Wyoming and Montana should jointly help pay these costs. These are simple responses to an exceedingly complex problem, the solution of which probably would require the supreme efforts of many agencies. With the establishment of the Sheridan Area Planning Agency in 1975, the foundation required for such an effort hopefully has been formed. In addition, the States of Montana and Wyoming are participating in organizations concerned with energy-related problems such as the Western Regional Governor's Energy Policy Office. The legal barriers to such cost-sharing are formidable, however, and will not be resolved very soon. In the end, the problem of social "costs" in Wyoming versus economic "benefits" in Montana must be attacked by all concerned parties.

b. The people (Institute for Social Research, 1975)

(1) The employed

Employed respondents indicated that their anticipation of better job opportunities is dampened by the pervasive feeling that "outsiders" would get many of the better-paying mine jobs. Cooperative effort between the

Sheridan Employment Office and the Decker Coal Co. might clarify or mitigate that perception.[1]

(2) The elderly

Many older people in Sheridan live in their own single-family dwelling, and according to the survey, they preferred to continue doing so. Their ability to continue that lifestyle could be extended by increasing financial support for services offered by various social agencies administering to the needs of older people.

Another mitigation suggested was a mobile-home park especially designed for retirees who wanted to be free of maintenance costs and chores.

Sheridan and Sheridan County has begun to investigate the possibility of subsidized housing for senior citizens (see p. 604-605).

(3) The miners

Those presently employed in coal mines in the impact area felt that the availability of housing was and would continue to be their most severe impact problem. Mitigation measures are discussed under housing.

(4) Other Sheridan area residents

Other Sheridan area residents, including local businessmen, could benefit from knowledge of conditions in other communities impacted by coal development, such as Colstrip and Forsyth in Montana and Gillette and Rock Springs in Wyoming. Indeed, it would be wise to communicate with their counterparts in those communities to learn about successful and unsuccessful adjustments to coal-related developments.

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[1] Decker Coal Co. is a union shop.

Ranchester, Wyoming, a small community about 15 miles northwest of Sheridan, is preparing for growth in several ways. The schools recently passed a bond issue for a combination elementary and junior-high school building.

In 1975, Ranchester had one trailer park, and two new subdivisions were under construction. The developers and most residents seemed to oppose trailers in these subdivisions, preferring that, if growth comes, new people should be housed in permanent buildings.

Ranchester and nearby Dayton, Wyoming, are members of the Sheridan Area Planning Agency and are attempting to control the growth that they believe is coming. These communities expect that newcomers would prefer to live in the Ranchester area rather than in the city of Sheridan because of lower taxes and cheaper housing. Comprehensive plans have recently been completed for Ranchester and Clearmont, Wyoming (Sheridan Area Planning Agency, 1976a, 1976b).

(5) Ranchers living near the proposed Decker mines

Ranch size is an important factor in whether or not ranchers feel that they can accommodate coal development without disrupting their life style. Ranches are generally large in the Decker area, with perhaps an average of 400-600 cows per ranch. Ranchers interviewed felt that, because of the large size, they could lease part of their ranches to coal companies while continuing their cattle operation on the rest of the ranch. This approach could permit them to continue ranching until leasing eventually would require them to give up ranching entirely in the Decker area and move elsewhere.

c. Quality of life and social values (Institute for Social Research, 1975)

Impacts on social services could be mitigated by the implementation of adequately funded community planning and development programs. Efforts to mitigate social impacts on any community, however, are reactive and defensive inasmuch as development-related social changes are not of a community's making nor fundamentally under its control.

Sheridan residents interviewed felt that some of the best qualities of the small-town, Western way of life might be protected if mitigation measures were directed toward gradual and controlled development. This would require coordinated planning by local groups and the coal industry Respondents expressed doubt that either of these two groupings were ready for that kind of exchange. Some comments received are:

> "Speculators are planning. Other groups are wondering what to do. Big money talks and gets its way. What good will planning do, therefore?"

Others do not blame industry for inadequate planning. They comment that,

> "People don't care yet. Not until they are directly affected. Decker has been fair to this town. They have tried more than others ..."

From the 35 percent of those surveyed who checked "I need to know more about the expansion plans and the likely consequences," came such comments as this:

> "I'd like to hear plans from both Decker and the environmentalists at the same time and then weigh one against the other. People should really know much more about what the deal is all about and what it's going to cost them."

(1) Housing

(a) Implementation plans

The Housing Assistance Plan prepared by the Sheridan Area Planning Agency (1976c) is a key component of the city of Sheridan's Comprehensive Plan, it is anticipated that this plan would help ease the housing problems that the Sheridan area is currently experiencing. These problems will become more acute should the Decker Coal Co.'s proposals be approved. The Housing Assistance Plan presents: (1) A study of existing housing characteristics and housing problems, (2) housing goals and objectives for Sheridan and Sheridan County and, (3) a program for implementing local housing plans (Sheridan Area Planning Agency, 1976c). The plan suggests that the following actions be taken to help develop adequate housing in the county:

First year implementation action

1. Review and adopt the housing assistance plan and housing element,[1] including a statement of goals and objectives.
2. The towns of Dayton, Clearmont and the county should consider establishing a building permit system along with building, electrical, and plumbing codes. Fire codes should also be established.
3. Through a coordinated effort, building inspectors should be employed on an areawide basis to provide services to the communities and county that do not have a building inspection program.
4. An areawide housing information system of recording new mobile homes brought into the region, new homes constructed, plus demolitions accomplished, should be developed. The Sheridan Area Planning Office can develop a master form and implement this activity through the permit system.
5. The mobile home regulations for the county and communities should be continually reviewed and updated to encourage new design methods.

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[1] The housing element is a portion of the city of Sheridan's Comprehensive Plan (Sheridan Area Planning Agency, 1977).

6. Private lending institutions should establish policies to aid building, constructing, or remodeling housing units. Builders should be assisted in determining the housing needs and sources of financing available.

Second year implementation action

1. Continue the projects listed in the first year action program that have not been completed.
2. Determine the feasibility and need, if any, to form an areawide housing authority.
3. Continue implementing the three programs for constructing new units and rehabilitating deteriorating units.

Third year implementation action

1. Continue the projects listed in the first and second year programs that have not been completed.
2. Review and update this Housing Element.
3. Continue constructing new units and rehabilitating deteriorating structures.

The above implementation actions may need modification after annual review of housing goals and objectives in relation to current impacts of resource development on local communities and on Sheridan County.

(b) Federal housing programs

Publicly subsidized housing programs, i.e., low-interest mortgage loans, provide a partial solution to the current lack of adequate housing. Other solutions include such programs as subsidized home construction and remodeling. In accordance with their planning duties, SAPA has identified several Federal and State housing-assistance programs for which Sheridan area residents and communities might qualify.

In rural areas where home-construction and improvement loans are not considered safe risks by private financial institutions, the Federal government administers loan programs through the U.S. Department of Agriculture's Farmer's Home Administration (FHA).

Three major programs available through the FHA include: (1) Rural rental housing (Section 515), (2) home ownership rural credit (Section 502), and (3) existing house rehabilitation (Section 504).

Under the "rural rental-housing program", the FHA makes loans that provide for rental housing in the form of multiple-unit dwellings for low- to moderate-income persons, or those 62 and older. The definition of a rural area has been expanded to include places having (1) populations greater than 10,000, but less than 20,000, and (2) a serious lack of mortgage credit as determined by the Secretary of Agriculture and the Secretary of Housing and Urban Development. In addition to construction, rural rental-housing funds may be used for purchasing building sites; for providing rental housing with streets, water, waste disposal, and laundry facilities; and for paying for landscaping and other beautification measures.

The "home-ownership rural-credit program" is applicable in rural areas, including open country and cities, that have populations of less than 10,000. Through this program, home-ownership loans are available to build, improve, repair, or rehabilitate homes, farm-service buildings, and waste-disposal systems and to provide water for household and farm use. The program is intended to help low- and moderate-income families purchase an existing home or purchase a site on which to build a home.

The "existing-housing rehabilitation program" provides monies for owner-occupants who cannot qualify for a regular rural-housing loan. This program will loan and/or grant up to $5,000.00 for repairs to an existing home. The Farmer's Home Administration (FHA) must review the plans for the proposed work and inspect the actual construction.

The FHA also provides mortgage credit to qualified home buyers. Mortgage limits have recently been increased to $45,000 for a basic single-family home. In addition, a new FHA co-insurance authority has been created to assist with single and multi-family home mortgages. Construction performed under this program must be inspected to insure compliance with certain minimum acceptable standards. This is a demonstration program, and the U.S. Department of Housing and Urban Development (HUD) is required to consult with private mortgage-lending institutions to insure that the program does not disrupt the mortgage market.

HUD also provides housing loans for qualified applicants. Under the "Section 8" program, assistance is granted to eligible families occupying new, substantially rehabilitated, or existing rental units through assistance payment contracts with the owners of the rental units. The "Section 8" program also provides for the subsidization of local housing authority bonds.

The Department of Housing and Urban Development also administers a program for funding housing projects in communities with low- to moderate-income families and administers monies to provide for housing construction for the elderly, the handicapped, or the developmentally disabled.

(c) Other possible mitigating measures

The Sheridan Area Planning Agency has identified five possible Wyoming programs that would help low-income families meet the high cost of housing.

These programs include: State cash vouchers, State housing-service vouchers, a State Public Housing Agency, State-subsidized housing mortgages, and State-sponsored local tax abatement. None of these programs is currently in operation (SAPA, 1976c). In addition, should the Wyoming Community Development Authority receive a favorable decision on a case currently pending before the Wyoming Supreme Court, housing loans at approximately 7½ percent interest annually would become available through private lending institutions.

Construction of mobile-home parks would provide the least expensive solution to the housing shortage in Sheridan and Sheridan County, but this approach would create other social problems. Construction of mobile-home parks might increase impacts such as tax inequities and service deficiencies (Institute for Social Research, 1975).

In response to a question about who should pay for increased cost of services, respondents to the Institute for Social Research survey suggested that, although it might be unfair to expect the employer to help pay for most tax-supported services, companies should help provide housing for their workers. Housing assistance at or near the mine site would not only ease Sheridan's housing problem but might moderate other related impacts. Workers choosing to live in Montana would be free of some of the double-tax burden that has been especially aggravating. School impact would be concentrated in the area where revenues from the coal tax would be available for school construction and operation. Economic benefits and service impacts would probably be distributed more evenly among Sheridan and Big Horn Counties.

Perhaps some consideration should be given to examining the best features of the old company towns like those that served the deep mines around Sheridan, Wyoming. Also, much could be learned from the mistakes and successes of experiences such as at Colstrip, Montana, that might spark some innovative, industry-led, mitigating measures for housing. Hopefully, the industrial committee organized by the Sheridan Chamber of Commerce would be of assistance in this approach.

(2) Water and sewage

On completion of the ongoing study of the water distribution system, the city of Sheridan should utilize the study and begin updating the system. Until the water and sewage systems are expanded, commitments to additional users should be made with considerable caution.

(3) Transportation

The Montana Department of Highway's current survey of highway needs in the coal-development area of southeastern Montana would be of use in transportation planning. Commuter bus service between Sheridan and the Decker mines would be in the interest of all concerned.

Wear and tear on Montana highways impacted by coal development would be at least partially mitigated by use of the Coal Area Highway Department Fund. Ten percent of the Montana coal-tax revenues are earmarked for the reconstruction of 12 segments of primary and secondary highways in the coal-impacted areas of Big Horn, Rosebud, and Treasure Counties. These funds are to be used in matching Federal funds to reconstruct and repair highways that have deteriorated from heavy use associated with coal development. It is projected that $6.66 million will be credited to the fund during the 1977 biennium (Himsl, 1975).

(4) Schools

School District No. 2 (Sheridan) could immediately begin searching for capital expansion funds from the States of Wyoming and Montana, the Decker Coal Co., and the Federal Government. The district's ability to build new classrooms is limited by its legal restrictions on expenditures for capital facilities and by voter unwillingness to accept increased indebtedness. The district could begin a public information program to inform residents of the need for increased capital spending. If the allowable bonding limit is increased by the State of Wyoming, the district should ask the voters for new facilities. In response to the question regarding which community service Sheridan respondents would be most willing to support with increased taxes, "schools" was far ahead of police, health care, and street repair.

Potential sources of emergency funding for Sheridan schools include the FHA's Farm Loan Board; however, only about $2 million are available for Sheridan. This amount may not be adequate to meet school-district needs. The Community Development Authority of HUD could be another potential source of school funds, as could monies generated by a possible increase in the Wyoming coal-severance tax. An increase in this severance tax is currently under discussion by the Wyoming Legislature.

According to an official of the Wyoming Department of Education, a lease-purchase building program of the type currently underway in Wheatland, Wyoming, may prove helpful to Sheridan. Under this program, the school district can negotiate with an energy company for the construction of a school building. The school district then leases the building from the company under an agreement that conveys ownership to the district after a designated period of years. The industrial committee organized by the

Sheridan Chamber of Commerce could provide similar innovative solutions to school-funding difficulties.

Another feasible method for expanding a school district's building program is the approval by voters of bonding levels over and above the current limit of bonded indebtedness. If the district received voter approval to increase the allowable bonded indebtedness by $500,000, the school district could sell the additional bonds over a period of time to accomplish necessary capital improvements.

The grade school near Decker could accommodate about thirteen additional students if a teacher's aide were hired. Should more than a few housing units be made available in the Decker area, however, the school would have to be expanded.

(5) Recreation

Most of the respondents in the study area talked about recreation in terms of a tradition of easy access to "our mountains and fishing sites" and expressed resentment toward "rich ranchers and Eastern dudes" who lease public lands and then limit access to them. Local users and land agencies could seek solutions to this irritating situation before pressure from a growing number of frustrated users reaches the point of hostility.

The Sheridan YMCA, whose recreation program is extensive, reportedly is considering a plan to reduce membership costs for those who cannot afford the full amount.

(6) Public safety

The city of Sheridan and Sheridan County could begin planning for the extra funding necessary to hire and train additional law-enforcement officers. As noted above, most respondents chose "schools" as the service they would be most willing to support with more taxes; "police" was their second choice.

The city of Sheridan could evaluate requests for new building permits in view of the impact that construction would have on existing waterlines. Such an evaluation would help maintain adequate fire protection. The city of Sheridan also could develop plans for replacing those waterlines identified by the recently completed water and sewer study as being inadequate.

(7) Social and welfare services

The primary demand on social-service agencies would be for housing assistance. Increasing costs and almost no vacancies have already burdened low-income clients, and it is almost certain that construction of additional facilities would lag far behind the demand which mine expansion would create. Only a substantial increase in clients' assistance allowances would help them compete for suitable housing.

(8) Health services

Montana and Wyoming could join with Sheridan, Campbell, and Johnson Counties in planning for future health-care facilities in the Sheridan County area. This broad base for planning is necessary because the Sheridan facilities serve a wide area, whereas the hospital is supported primarily by Sheridan County taxpayers.

Ambulance service should be assumed by Sheridan County so that expansion of services or addition of equipment would be controlled by the county and, thus, would be more responsive to its rapidly changing health-service needs.

Decker Coal Co. officials have indicated that an ambulance and crew would be on duty at the proposed new mines. Also, first-aid training would be required for all supervisors at the new mines.

6. Archaeological and historical sites

a. Statutory requirements

In the event that sites of archaeological or historical significance are discovered during the mining process, State and Federal regulations require that mining activities cease until site analysis and, if appropriate, the salvaging of artifacts have been completed. The Montana Department of Highways also requires that the Decker Coal Co. cease construction activities pending a site analysis should artifacts be uncovered during relocation of the secondary highway. Similarly, Big Horn County requires a cessation of activities should artifacts be uncovered during construction of the county-road realignment pending a site analysis and recovery of artifacts.

In addition, several Federal and State laws protect cultural and paleontological resources, e.g., the Antiquities Act of 1906; the National Historic Preservation Act of 1966; Executive Order 11593, "Protection and Enhancement of the Cultural Environment," 1971; the Archaeological and Historical Conservation Act of 1974; and the Montana State Antiquities Act of 1973. These laws would be applicable to the proposed mining actions for the East Decker and North Extension areas.

b. Other mitigating measures

Fredlund (1976) identified 12 archaeological sites within the East Decker and North Extension project areas, and Lahren (1976) found an additional eight sites within these areas.[1/] With exception of site 24BH1525, Fredlund

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[1/] Fredlund identified a total of 15 sites in her "survey area", which was somewhat larger than the two project areas encompassing the proposed East Decker and North Extension mines (fig. 63A).

recommended that no further appraisal was necessary for the sites she identified inasmuch as each of her sites had been sketch mapped and power augered to test the subsurface.

Conversely, additional appraisal would be necessary for all of Lahren's sites because they had only been identified. No historical or archaeological sites within either of the proposed mine areas are currently listed in the National Register of Historic Places, and to date, no sites within these areas have been nominated for inclusion in the register. Some professional differences of opinion exist within the State, however, as to the probable eligibility of at least one site (No. 24BHB14) in the East Decker area in the NE¼ sec. 13, T. 9 S., R. 40 E. (Ken Korte, State Historic Preservation Officer, written communication, February 4, 1977).

Fredlund and Lahren recommend that the following site-specific actions be taken prior to any mine-related surface disturbance of the sites they have identified.

(1) Site No. 24BH1525 requires a subsurface examination to confirm the presence or absence of deeply buried material (Fredlund, 1976).

(2) Site Nos. 24BHB09, 24BHA29, 24BHA32, 24BHB12 and 24BHB13 (all ridge-crest habitation sites) require a gridded, systematic surface collection and detailed technological analyses of the recovered materials (L. Lahren, written communication, February 4, 1977).

(3) Site Nos. 24BHB11 and 24BHA30 (stream terrace, open camps) require a gridded systematic surface collection, horizontal and vertical sub-surface testing and detailed technological analyses of the recovered materials (L. Lahren, written communication, February 4, 1977).

(4) Site No. 24BHB14 (a network of stone lines, cairns and circles) require plane-table mapping and detailed testing, especially in the area of a suspected bison kill. This site should be tested to determine its eligibility for inclusion in the National Register of Historical Places (L. Lahren, written communication, February 4, 1977).

(5) In addition to those archaeological sites discovered by Lahren, he also identified a group of foundations and ruins adjacent to the east shore of the Tongue River Reservoir. These sites should be adequately described, photographed, and appraised (L. Lahren, written communication, February 4, 1977).

Some controversy exists regarding the adequacy of the 1975 archaeological survey completed by Fredlund on the East Decker and North Extension project areas. That controversy centers on professional differences of opinion as to what constitutes an archaeological site and whether Fredlund's archaeological study was sufficiently thorough to adequately appraise the archaeological resources of the Decker area (see responses to public comments on the Draft EIS, Appendix M).1/

1/Fredlund in her 1975 survey of the East Decker and North Extension areas defined a site as follows; a site must contain within a three (3) meter square area (a) two recognizable tools with associated flakes, and/or (b) 15 flakes, and/or (c) a feature such as a hearth, rock structure, rock ring, etc., (Lynn Fredlund, written communication, January 7, 1977).

Lahren in his 1976 survey of the North Extension area and a part of the East Decker area mapped a site on the basis of the following definitions (L. Lahren, written communication, December 26, 1976):

> "A site is any place, large or small, where there are to be found traces of ancient occupation of activity***. There are millions of sites on the earth, some of which are as large as a city, others as small as the spot where an arrowhead lies." (Hole and Heizer, 1973).
>
> "A site is the smallest unit of space dealt with by the archaeologist and the most difficult to define. Its physical limits, which may vary from a few square yards to as many square miles, are often impossible to fix." (Willey and Phillips, 1958).

Because of this controversy, two archaeologists were consulted by the Department of State Lands to appraise the adequacy of Fredlund's study (see Appendix I). Dr. Thomas Roll of the Montana State University questioned the systematics of Fredlund's survey and the absence of subsurface testing in a variety of localities of possible subsurface deposition (T. Roll written communication, December 15, 1976). Dr. Dee Taylor of the University of Montana also expressed the need for a fuller explanation and justification for decisions regarding the testing and relative importance of sites (D. Taylor, written communication, December 8, 1976). Given the available information for the two studies, however, neither of these archaeologists recommended that a new study be completed. Dr. Roll did suggest however, that the question of the adequacy of Fredlund's study be referred to the State Historical Preservation Officer for further review.

After reviewing the results of the Fredlund's and Lahren's studies for the East Decker and North Extension areas, the State Historic Preservation Officer requested that his office be advised as early as is feasible on an annual basis, of those specific areas that would be mined during the subsequent year. The Preservation Officer also requested that he be given the opportunity to test or arrange for testing by other parties, any sites that would be impacted during the following year. The Preservation Officer anticipates that within several years or less the Montana Historical Society will determine the eligibility of Site No. 24BHB14 for inclusion in the National Register. Thereafter, annual review of areas to be mined should be unncessary (Ken Korte, State Historic Preservation Officer, written communication, February 4, 1977).

Because (1) the Montana Historical Society requested that additional site testing be conducted on the proposed mine areas, (2) the Fredlund survey was made during a period of above normal vegetation growth, which would tend to conceal potential sites (Lynn Fredlund, written communication, December 3, 1976), and (3) questions have been raised regarding the subsurface testing program performed by Fredlund, it may be in the best interest of the parties concerned that additional studies as required be completed on the proposed Decker mine areas. Such studies would eliminate lingering questions about the archaeological resources of the project areas--questions that otherwise could jeopardize decision-making by the Decker Coal Co., by the U.S. Geological Survey and by the Montana Department of State Lands during the 20-year period of mining proposed for the East Decker and North Extension areas.

As a minimum mitigating requirement, a stipulation could be added to the initial mining permits for the East Decker and North Extension areas that would require the Decker Coal Co. to allow the Montana Historical Society to test or to arrange for testing by other parties all those sites that would be disturbed by mining. In that event, the Decker Coal Co. and the State Historic Preservation Officer should agree on the contractee and the study methodology for the sites to be tested on the two proposed mining areas.

7. Recreation facilities and activities in the Decker area

The loss of approximately 9,000 acres of potential recreation area in the Decker vicinity by mine-boundary fencing would be partially mitigated by successful reclamation of the existing West Decker and the proposed mine areas.

During the life of the proposed mines, land within the fenced mine boundaries would serve as refuge for those wildlife species that are tolerant of nearby mining activities and the associated noise. This could partially mitigate any increase in hunting pressures resulting from mining-related population influx to the Decker area. Inadvertent losses of game animals from poaching or vehicle collisions could be greatly reduced by educating mine workers unfamiliar with animal habits, local migrations, and the overall wildlife land-use situation.

Mine employees are not permitted to bring fire arms to work (Decker Coal Co., 1975a). In addition, Decker Coal Co. management indicates that employees who violate fish and game regulations on the job or enroute to work will be dealt with harshly (VTN Colorado, 1975b). This action should serve to reduce the indiscriminate killing of wildlife by Decker personnel.

Lastly, the Decker Coal Co. has offered to contribute $100,000 initially for construction of new recreation facilities at the site of the existing Tongue River Recreation area (fig. 87) and $5,000 annually for a period of 20 years for maintenance of these facilities (Ron Holliday, Montana Department of Fish and Game, oral communication). Preliminary planning for such facilities have been undertaken by the Montana Fish and Game Department, Division of Parks and Recreation (fig. 72A). Should this proposal be implemented, the expected increased use of the Tongue River Recreation area as a result of increased mining activity should be at least partially compensated for by the improved quality and capacity of this new facility. Relocation of Route FAS 314 in the North Extension area would provide improved access to the Tongue River Reservoir and the recreation area.

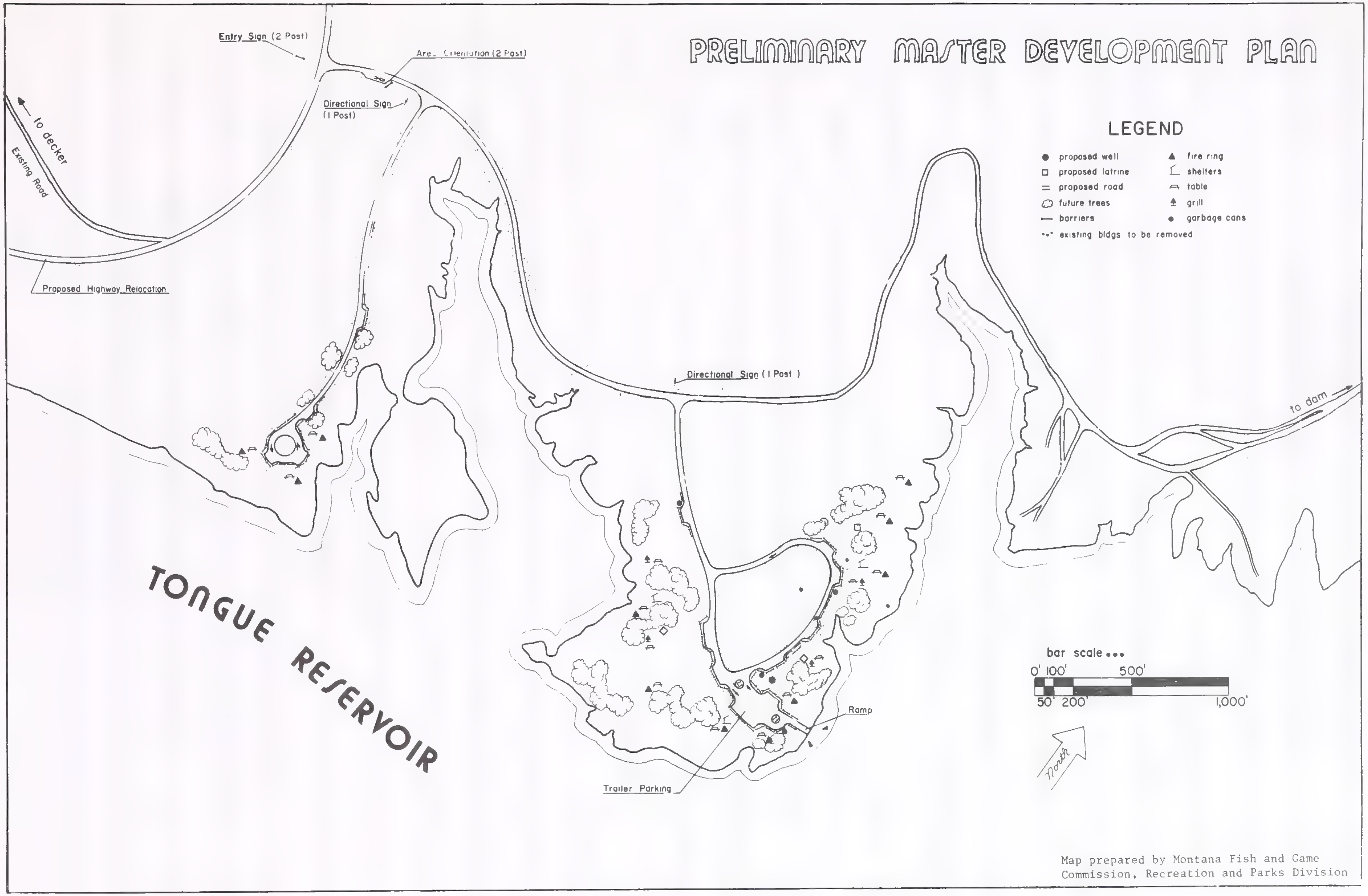

PRELIMINARY MASTER DEVELOPMENT PLAN
LEGEND
proposed well
proposed latrine
proposed road
future trees
barriers
existing bldgs to be removed
fire ring
shelters
table
grill
garbage cans
Entry Sign (2 Post)
Area Orientation (2 Post)
Directional Sign (1 Post)
to decker
Existing Road
Proposed Highway Relocation
Directional Sign (1 Post)
to dam
TONGUE RESERVOIR
Trailer Parking
Ramp
bar scale
0' 100' 500'
50' 200' 1,000'
North
Map prepared by Montana Fish and Game Commission, Recreation and Parks Division

Figure 72A.– Preliminary master development plan for the Tongue River Recreation Area (see fig. 87 for location map).

A map showing the Master Recreation Plan proposed for the Tongue River Reservoir is included in Appendix L. This plan was prepared by the Montana Fish and Game Department, Recreation and Parks Division.

8. Aesthetics

Impacts on the aesthetic quality of the project area during mining cannot be totally mitigated. Reclamation work planned in conjunction with mining activities, however, would help reduce impacts. Recontouring, topsoiling, and reseeding of spoil ridges would be accomplished as room becomes available to proceed. Backfilling, recontouring, and topsoiling would be completed no later than 90 days prior to seeding any portion of mined land, which should lessen the magnitude and duration of visual impacts. At the completion of mining activity, reclamation, if successful, should return the area to an aesthetic setting similar to that which existed prior to mining.

9. Highway facilities

The Decker Coal Co. has stated that the county road in the East Decker area and Route FAS 314 in the North Extension area would be relocated at their expense. The cost of relocation of Route FAS 314 could be as much as $160,000 to $175,000 per mile; while cost of the county road relocation could exceed $30,000 per mile.

To mitigate air-quality impacts, the Decker Coal Co. would be required to adhere to the same State and Federal air-quality laws that govern Montana Department of Highway construction projects. The Montana Department of Health and Environmental Sciences has advised the Montana Department of Highways that dust-preventative measures should be taken during construction to reduce air-borne particulate matter.

Water-quality impacts related to the county road and Route FAS 314 relocation would be reduced by requiring the Decker Coal Co. to adhere to all State and Federal laws and regulations regarding water quality. Accordingly, temporary erosion-control measures and the establishment of vegetation on disturbed areas would be required of the Company. Where the proposed realignment of Route FAS 314 crosses the drainages of Spring Creek and Pearson Creek, if that stream is not made a permanent tributary of Spring Creek (p. 382), the Company would be required to consider flood data in their design of crossings and to provide adequate embankment protection to minimize erosion.

10. Train traffic

As a result of public comments received regarding the Decker mine proposals, the Montana Highway Department has approved a project to construct a railroad underpass that would eliminate the existing at-grade crossing of Route FAS 314 by the Decker spur line (fig. 10). This project, which also has been approved by the Federal Highway Administration, has been added to the Highway Department's five-year construction program. The preliminary recommendation of Highway Department engineers is that the railroad pass through a multiplate tubular steel structure constructed beneath Route FAS 314 (see Highway Department memorandums in Appendix K). Engineering studies for this underpass should be completed in the near future.

Similarly, an overpass or underpass could be constructed on the Decker spur line where it crosses Wyoming Highway 336 to largely mitigate the impacts of increased train traffic from the proposed Decker mines on the Wyarno community. The Wyoming Highway Department has appraised the severity of this impact and concluded that "*** it does not now appear that the Wyarno crossing would be accorded a high priority in the near future." Accordingly, no overpass or underpass is planned for that crossing until the number of unit trains approaches the potential of 20 per day or until a significant increase in traffic occurs on Highway 336 (Leno Menghini, Wyoming Highway Department, written communication, January 25, 1977). In the interim, Menghini states that the Department believes "*** that the coal companies and the railroad have a responsibility to operate this spur line in a manner that will not cause unreasonable hazards or unreasonable inconvenience to the local residents; ***."

Train traffic on the spur line to the East Decker mine and increased train traffic on Burlington Northern and other connecting main lines as a result of the proposed Decker mines would probably not warrant the construction of additional traffic-separation structures at road crossings. The obstruction of traffic at these crossings can be minimized, however, by responsible maintenance of the trackage and equipment to reduce breakdowns and by scheduling trains so as to avoid excessive rail traffic at the more severely impacted crossings during those hours of maximum crossing use.

As other mines in this general area are opened over the next decade, train traffic will increase to the extent that traffic-separation structures at all principal road crossings will be essential to avoid disruption of local traffic. Increased revenues to the railroad companies from the profitable unit-train traffic and to the Federal, state, and county governments from increased taxes and royalties on the coal production would provide a source of funding. Increased revenues to the railroad companies also would more than offset the anticipated increased track and equipment maintenance costs and would provide the monies necessary to upgrade substandard fences and to provide additional right-of-way maintenance to decrease losses of livestock and wildlife and reduce the hazard of railroad-caused fires.

Increased wind blown and accidental spillages of coal could be minimized by spraying the coal surface in each car with an organic sealant or oil film and by adequate maintenance of trackage and equipment.

Many, if not most, impacts stemming from coal transportation from the proposed Decker mines to user areas in Illinois, Michigan, and Texas by unit trains, by shipping on the Great Lakes, and by barges on the Illinois River could be avoided by moving the coal to user areas through slurry pipelines. A discussion of the use of slurry pipelines as an alternative coal-transportation method is presented on page 822-823.

V. ADVERSE IMPACTS THAT CANNOT BE AVOIDED IF THE PROPOSALS ARE IMPLEMENTED

A. Depletion of natural resources

1. Coal

The proposed Decker mines would remove approximately 180 million tons of subbituminous, low-sulfur coal from the area. This would represent a permanent depletion of a fossil fuel resource. Averitt (1975, p. 15) estimates the total strippable and underground coal resources of Montana to be about 292 billion tons. He also estimates (1975, p. 33) that, of this amount, about 42 billion tons could be extracted by present (1974) surface-mining techniques. The coal to be mined in the East Decker and North Extension areas represents about 0.06 percent of the total coal resources of Montana and about 0.43 percent of the strippable coal resources.

2. Superjacent minerals and construction materials

An indeterminate amount of clinker would be intermixed with other spoil materials and thereby lost to future use as a construction material in the immediate area. This loss is not significant, however, because of the vast amount of clinker in the surrounding area. A small amount of gravel that caps terrace remnants in the East Decker area also would be intermixed with other spoil materials and lost to future use as a construction material. However, these deposites generally are not more than a few feet thick, have very limited area extent, and contain sufficient fine-grained materials that they are of doubtful economic value.

No other mineral deposits are known to occur in the area.

3. Water resources

a. Ground water

(1) Removal of aquifers

If the proposed plans are implemented, all aquifers within the mined interval in the East Decker and North Extension areas would be removed. Aquifers removed in the East Decker area include parts of the Anderson, Dietz 1, and Dietz 2 coal beds, lenses of sandstone in the interburden and overburden, the alluvium underlying the floors of Middle Creek and Coal Creek valleys, and a relatively thin zone of saturation at the base of the Anderson clinker. Only the coal beds are currently (1976) used as a source of water supply within the area to be mined. Aquifers removed in the North Extension area include the Anderson-Dietz 1 and the Dietz 2 coal beds, possibly some lenses of sandstone in the interburden between these two coal beds, alluvium underlying the floors of Spring Creek and Pearson Creek valleys, and the Anderson-Dietz 1 clinker. As in the East Decker area, the coal beds are the principal source of water supply in the area to be mined. Approximate areas of aquifers that would be removed in the proposed mine areas are given on page 440.

Existing aquifers would not be physically altered outside the mined areas. Within the mined areas, they would be replaced by a single aquifer that should be capable of storing and transmitting larger amounts of ground water than the removed aquifers. Saturation in the spoil aquifer would occur under water-table conditions.

(2) Modifications of ground-water flow by replaced spoil materials

Upon completion of mining and termination of pumping, discharge of mine-effluent water to the Tongue River Reservoir would cease, but inflow from the reservoir to the mined areas would continue until spoils in the mined areas are saturated to a level where ground-water flow to the reservoir would eventually resume. In the event that the two proposed mining operations were discontinued simultaneously, initial loss of water to the reservoir could be as much as 18 to 24 acre-feet/day (about 2 percent of inflow to the reservoir on an annual basis). Inflow to the mined areas would be greatest initially and generally would decrease progressively over a period of as much as 15 years. Thereafter, ground-water discharge to the reservoir should resume at essentially the premining rate.

(3) Deterioration in water quality

Available data indicate that ground water moving through the replaced spoil aquifer would increase appreciably in dissolved-solids content as a result of leaching. This deterioration in water quality would depend on the amount of soluble materials in the spoil and on the residence time of the water in the spoil. Some leaching is expected during the period of mining; the greatest deterioration in water quality, however, should occur after reclamation is completed and ground-water movement is once again toward the Tongue River Reservoir.

Significant deterioration in water quality is expected in the East Decker area where the bulk of the spoil would be composed of fine-grained materials obtained from the Tongue River Member of the Fort Union Formation. The dissolved-solids content of the water is expected to increase from about 2,500 mg/1 before mining to possibly as much as 6,000 mg/1 after mining. The water probably would be rich in sodium and sulfate and have a sodium adsorption ratio in excess of 50.

Somewhat less deterioration in water quality is expected in the North Extension area where the bulk of the spoil would be composed of clinker, which generally contains only small amounts of soluble materials. The dissolved-solids content of the water is expected to increase from about 1,500 mg/l before mining to about 2,000 mg/l after mining. The sodium adsorption ratio probably would increase from less than 5 to about 10.

Despite this deterioration in water quality in both the East Decker and North Extension mine areas, the effect on the use of the Tongue River Reservoir or its water should be insignificant owing to the relatively small amount of reservoir inflow that would be derived from the proposed mine areas. The net change in quality of the reservoir water probably would be difficult to detect by standard sampling and testing procedures.

In the strictest sense the deterioration in ground-water quality in the mined areas is not an irreversible adverse impact, because eventually the leachable materials would all be removed from the spoils and the quality of the water would improve accordingly. Effective leaching, however, would probably take many hundreds or thousands of years. For all practical purposes, therefore, the deterioration in ground-water quality that would occur as a result of mining is a long-term impact that cannot be avoided.

b. Surface water

(1) Alteration of stream channels

Implementation of the proposed plans would result in the removal of the existing drainage net within the mined parts of the East Decker and

North Extension areas. The lower reach of Deer Creek valley adjacent to the East Decker area would be partially filled with spoil materials. Channels removed in the East Decker area include those of Middle Creek, Coal Creek, and 14 comparatively small unnamed ephemeral streams. Channels removed in the North Extension area include those of Spring Creek, South Fork Spring Creek, Pearson Creek, and 6 comparatively small unnamed ephemeral streams. The lengths of the respective valleys that would be altered by mining are listed in table 45.

Principal drainage courses removed during mining would be replaced by depressions left in the reclaimed surface. Erosion by streams entering the reclaimed area over the highwall could be prevented by the design and construction of wide rock-lined channels, but these "engineered" channels would present an unnatural appearance to the landscape. Moreover, these lined channels, no matter how carefully designed and constructed, might require maintenance to prevent deterioration and eventual failure.

(2) Decreased runoff to the Tongue River Reservoir

Modification of the surface in the proposed mine areas and diversion of surface runoff around the active pits should increase evapotranspiration losses and thereby decrease runoff to the Tongue River Reservoir. It is estimated that the concurrent operation of the East Decker and North Extension mines would reduce annual runoff to the reservoir by no more than about 165 acre-feet annually during mining and about 85 acre-feet annually after mining (table 46). This loss of water to the reservoir represents less than five-hundredths of 1 percent of total annual inflow to the reservoir during the period of mining and less than three-hundredths of 1 percent of total annual inflow after mining.

(3) Changes in chemical quality of water

Leaching of spoils would increase the dissolved solids content of ground-water discharge from the mined areas to the Tongue River Reservoir both during and after mining (table 44). Because of dilution, however, the impact on the use of the reservoir for recreation, for fish and wildlife habitat, or for water for downstream irrigation should be insignificant. Changes in water quality would probably be difficult to measure by standard sampling procedures and laboratory methods.

(4) Sediment yield to the Tongue River Reservoir

Long term sediment yield to the Tongue River Reservoir probably could be reduced significantly from premining rates by using appropriate mitigating measures. Areas of sediment accumulation within the reservoir, however, would be changed by the diversion system. During mining, sediment would no longer enter the reservoir at the mouths of Deer, Middle, and Coal Creeks in the East Decker area and at the mouth of Pearson Creek in the North Extension area. Instead, sediment would enter the reservoir at the mouths of the diversion channels (figs. 10 and 20). After mining, sediment would continue to enter the reservoir through the Deer Creek diversion channel until its eventual failure. Except for Pearson Creek, which would be made a permanent tributary of Spring Creek, other streams would enter the reservoir at approximately their premining locations.

B. Topography

Alteration of the topography in the East Decker and North Extension areas cannot be avoided if these areas are mined. A general lowering of the surface would occur as a result of the removal of a thickness of not less than 15 feet and possibly as much as 70 feet of coal from the subsurface. Expansion of the overburden during mining, however, would partially or largely offset this effect depending on the local thickness of the overburden. Replaced spoils excavated and moved by dragline initially occupy about 25 percent more volume than the unbroken rock prior to mining. Subsequent compaction of dragline-laid spoils may reduce this added volume to about 20 percent. Thus, in areas of comparatively thin overburden and thick coal beds, the surface may be lowered as much as 20 feet; in areas of thick overburden the surface would not be lowered appreciably. Because of this general lowering of the surface, the topography cannot be restored to its original configuration. With some exceptions, however, it can be approximately restored. The proposed topography and drainage in the East Decker and North Extension areas after reclamation is completed are shown in figures 9 and 19, respectively.

C. Soils

Soils would be removed, mixed, altered, and replaced on 4,000 to 5,000 acres disturbed directly by mining and related activities. Some additional soil disturbances would occur in adjacent areas from offroad vehicle travel and other activities indirectly related to the proposed operations. Disturbed areas would experience unavoidable loss of productivity during the period of disturbance and some lesser loss of productivity until complete rehabilitation is accomplished.

Short-term and possibly some long-term effects of reduced productivity, permeability, and infiltration capacity of the disturbed soils are unavoidable. Soil depths would be decreased in valley bottoms, thereby adversely affecting reestablishement of deep-rooted plant species. Increased soil losses from erosion by wind and water and increased sediment yield to the Tongue River Reservoir would occur, but their magnitudes cannot be determined from available data.

D. Air quality

The major unavoidable adverse impact to air quality would be the minor amounts of coal and soil dust created by the surface-mining activity. The operation of mining equipment, haulage trucks, locomotives, and other mine-related machinery would emit gaseous and particulate pollutants into the airshed. This would cause a reduction of air quality on the proposed mine site and downwind (VTN Colorado, 1975a, 1975b).

E. Vegetation

Unavoidable adverse impacts of the proposed project on the mine site vegetation are questionable as to severity and duration. Two impacts that cannot be mitigated are rearrangement of the size, area, and location of vegetation community types present in the areas that would be disturbed and reduction and alteration of species diversity within the various communities.

As processes of natural secondary succession continue within the reclaimed area, the new plant associations will distribute themselves into areas most suitable for their growth. These natural processes are extremely subtle and involve many variables; therefore, no time frame has been postulated for the complete process of secondary succession to climax vegetation, if indeed attainment of former climax is possible on these sites.

F. Wildlife

1. Mammals and birds

All species of wildlife utilizing areas that would be disturbed by mining activities would suffer unavoidable habitat losses, at least until such time as mining activities cease and the areas are revegetated. Human activity associated with the mining operation would also impose some unavoidable impacts. Species such as antelope or sage grouse, which have very specific habitat requirements (i.e., sagebrush) and do not tolerate increased human activity, would be severely affected, at least until such time as native range species begin reappearing on the recontoured mined areas. For other wildlife species, such as white-tailed deer, which more readily tolerate increased human activity and whose habitat requirements would not be as severely affected by mining, impacts would be less severe.

2. Fish

If potential erosion, sedimentation, or other water-resource contamination is controlled, no unavoidable adverse impacts on the fisheries in the Tongue River Reservoir would occur (VTN Colorado, 1975a, 1975b).

G. Loss of forage

By fencing the proposed mine boundaries, 6,300 acres of grazing land representing a livestock carrying capacity of approximately 1,000 AUM's would be lost for at least the 20-year duration of the projects. If range productivity on the reclaimed mine areas is not as high as before mining, the productivity of the mine areas for raising livestock would have been partially sacrificed for mineral production.

H. Economics (Polzin, unpublished manuscript, 1975)

The state of Montana and local governments in the Montana portion of the impact area are projected to have sizable revenue surpluses from the proposed Decker mines. Governments in Wyoming, however, would probably experience deficits. At first glance, the solution simply requires the transfer of funds from one governmental unit to another. However, viewing this solution in light of the politics involved, one realizes that such a transfer would involve actions by two state governments plus numerous local governments and, thus, would require an unprecedented degree of coordination and cooperation. Owing to institutional constraints, some inequities are almost inevitable; therefore, little hope exists for solving these inequities before impacts from the Decker mine proposals would occur.

I. Social structure and social services (Institute for Social Research, 1975)

1. Housing

Some adverse impacts on Sheridan's already strained housing market would be unavoidable, despite the efforts of the Sheridan Area Planning Agency to secure funding for planning, for community development, and for housing rehabilitation (Appendix G). A serious construction lag would occur, even if plans for housing construction were to proceed more rapidly than at present. As indicated in the previous sections of this report, the adverse impact on housing would affect social-service clients, the elderly, the workers--in short, almost everyone who lives in the city of Sheridan.

2. Quality of life and social values

Impacts to the qualities of life that attract people to ranching or to living in small communities would be irreversible to the extent that the new Decker mining activity would change the socioeconomic impact area from rural to industrial. Some temporary adverse impacts to the quality of life of those living near the project areas may also occur if the proposals are implemented; for example, disruptions to the rural setting would be caused by the noise, dust, and traffic associated with mining activity. It should be noted, moveover, that no amount of money would fully alleviate all negative effects of social impacts on human relationships and organizations.

3. Community services

The lag in providing community services to the growing population, like the lag in housing supply, appears to be inevitable. Therefore, adverse, unavoidable impacts on the quality and breadth of community services would occur if the proposals are implemented. A viable solution to the problem of how to pay for increased social costs in Wyoming when coal revenues generated by expanding Decker mining activity accrue to Montana has not yet been reached.

J. Aesthetics

During the life of the proposed East Decker and North Extension mines, all impacts to the aesthetic environment would be unavoidable and adverse. The length of time that this situation persists would depend on the success of the reclamation program designed for the mined lands. Residual man-made features such as elongate ridges and depressions that remain after mining might also unavoidably and adversely affect the aesthetic quality of the two mining areas.

Population growth in this rural area of the Northern Great Plains could adversely affect the aesthetic environment of the area long after the coal has been mined because of the increased human activity. It is impossible to predict the long-term effects of population increases at this time.

K. Highways

An unavoidable loss of grazing forage and wildlife habitat would result from the secondary-highway and county-road relocations. This loss may be short-term, however, depending on the success of reclamation efforts by the Decker Coal Co. on the abandoned right-of-ways once the alternate routes have been completed.

A decrease in the aesthetic values held by reservoir users may be unavoidable because of potential reactions to the visual impact of the company's proposed secondary alignment when viewed from the reservoir. Improved west shore access may also cause a decrease in the aesthetic or visual values of reservoir users.

Short-term decreases in air, water, and noise quality would be anticipated during construction. Unnoticed archaeological values could also be destroyed during construction.

The secondary-road relocation proposed by the Decker Coal Co. would cause an additional 1.41 miles of travel between common points compared to the present highway. This length plus the increased mileage caused by the company's 1972 relocation would result in a 3 mile increase in travel distance to the road user since 1972.

L. Train traffic

Big Horn County has no current plans to construct a grade-separation structure on the county road where it would cross the proposed railroad spur line to the East Decker mine. Obstruction of county-road traffic at this crossing, therefore, would be an unavoidable impact as a result of the proposals. A similar, but larger, impact would occur at the Wyarno crossing (p. 500) on Wyoming Highway 336 until the Wyoming Highway Department or the Burlington Northern constructs an overpass or underpass at that location. No such structure is planned by the Highway Department for the near future (p. 619). The Burlington Northern Railroad in a letter to the Powder River Basin Resource Council (Appendix M) also disclaims any obligaation on its part to construct a grade-separation structure at the Wyarno crossing. Burlington Northern argues that funds for such projects purportedly are available at the State and Federal levels.

Other unavoidable impacts as a result of increased train traffic are (1) periodic obstruction of at-grade road crossings on the Burlington Northern main line and other connecting railroads between the proposed mines and the user areas or transshipment terminals, (2) increased frequency of noise pollution, and (3) increased gaseous emissions and consequent air pollution along the railroad rights-of-way and adjacent areas.

VI. RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The following discussion appraises the extent of long-term impairment or enhancement of resource values that would occur, given the proposed short-term surface mining of coal in the Decker area. In this analysis of trade-offs over time and trade-offs among resource values, short-term refers to that period of approximately 25 years during and immediately following the proposed operations when mining and reclamation are to take place. Long-term is that period thereafter during which consequent impacts, both adverse and beneficial, still affect the environment.

A. Mineral resources

Short-term development of the coal resources in the East Decker and North Extension areas, as proposed by the Decker Coal Co., would result in the removal of all coal from these areas that is economically recoverable by surface-mining methods using large equipment, such as draglines to move the overburden (fig. 16) and shovels and haulers to move the coal (fig. 18). Because of the thick coal beds in the Decker area and the absence of any thin overlying or underlying coal beds that would not be recovered, the proposed operations should recover most of the coal resource in the mined areas.

Short-term removal of an estimated 180 million tons of low-sulfur coal from the Decker area and consumption of that coal in electric-power generation plants in Illinois, Michigan, and Texas would result in a permanent long-term loss of that resource to similar or other uses. Removal of this coal, however, would not physically impair long-term productivity of coal in adjacent unmined areas or prevent the future development by other than surface-mining methods of undisturbed coal beds underlying the mine areas at depth. Very possibly, however, the future development of coal resources in isolated areas adjacent to the proposed mines would be economically unfeasible. An example is the coal in sections 3 and 34 adjacent to the proposed North Extension mine (figs. 1 and 3). If this isolated area of coal is not mined in conjunction with the proposed operations in the North Extension area, that resource may be lost to future development and to long-term productivity.

Mining of the coal and consequent mixing of the overlying materials would result in a long-term loss of productivity of clinker for use as a local construction material. This loss would not be significant, however, because of the large amounts of clinker in adjacent areas.

No other mineral resources are known to occur in the area. However, in the event that other minerals are discovered locally, the proposed mining operations should not adversely affect the future productivity of these minerals by deep-mining methods or by the construction of oil and gas wells.

B. Topography

The proposed activities would result in a permanent change in topography in mined and spoil-disposal areas, thereby introducing long-term changes in related environmental factors affecting long-term productivity of the area. Changes in slope magnitude and slope aspect or direction would alter the local microclimate, producing corresponding changes in type, density, and vigor of the plant cover. This in turn would affect infiltration, runoff, erosion and sedimentation, and range productivity or carrying capacity for livestock and wildlife. The effects of these changes on long-term productivity are discussed in the following sections.

C. Soils

Soil disturbances on approximately 4,000 to 5,000 acres as a result of the proposed action would alter soil characteristics and probably cause some long-term decline in soil productivity. Soil losses would occur from accelerated erosion on denuded and disturbed areas during mining and reclamation. Also, organic content and biological activity in the replaced surface layer would be significantly decreased by mixing soil horizons and by stockpiling. Because soil-building processes are slow, even under humid conditions, a comparatively long period would be required for soil development under the semiarid climate in the Decker area, thus magnifying the short-term effects of mining on the long-term productivity of soils in the area.

Possibly, however, the long-term productivity of soils as a whole in the Decker area might eventually be greater than under premining conditions. Currently unproductive areas having thin, poorly developed soils on steep slopes or sodic-soils problems should be significantly benefited by reclamation. The increased productivity of these areas could more than offset the decreased productivity of certain plant species that are important to wildlife habitat. The effect could be detrimental or beneficial to the long-term productivity of certain wildlife species.

D. Water resources

1. Ground water

Ground-water discharge to the Tongue River Reservoir from the mined areas should return to approximately premining rates and saturation levels within about 15 years after mining operations are completed. Thereafter, water supplies suitable for livestock and wildlife could be obtained from wells less than 100 feet deep drilled in the mine areas. Water supplies suitable for domestic use could generally be obtained by drilling to depths of 300 to 400 feet. Leaching of spoil materials by ground water moving through the mined areas toward the Tongue River Reservoir would approximately double the dissolved solids content of these waters. The dilution afforded by the reservoir contents, however, would prevent any measurable impact to the reservoir, to its fisheries, or to use of reservoir water for downstream irrigation. Thus, no changes in ground-water quantity or quality are expected as a result of mining in the Decker area that would impair the long-term productivity of the environment.

2. Surface water

The proposed action is expected to result, at least initially, in a small long-term reduction in runoff from the mined areas to the Tongue River Reservoir because of the increased infiltration stemming from the elimination of small water courses in the reclaimed areas and the establishment of a more uniform plant cover than currently exists in the proposed mine areas. This increased infiltration would increase soil moisture for plant growth and could result in a long-term increase in vegetation productivity. More probably, however, erosion in time would resculpture the surface by cutting new channels on reclaimed slopes. The derived sediment would be deposited downstream along the bottoms of the larger postmining drainage courses traversing the reclaimed areas.

Decreased vegetation in eroding areas generally would be balanced by increased vegetative production on valley floors because of the influx of soil materials and the added run-in moisture. The net result would tend to encourage the long-term development of a diverse plant cover without significantly altering the overall long-term production of vegetable material within the reclaimed areas.

With application of proper mitigating measures to prevent valley trenching upstream from the mined areas, long-term sediment yield to the Tongue River Reservoir probably would be decreased. The effect would be to increase the useful life of the structure and thereby increase the long-term productivity of the reservoir fisheries and irrigated farmlands downstream, as well as to provide a long-term benefit to recreational values.

E. Air quality

Mining would reduce air quality in the proposed mine areas and downwind because of increases in air-borne particulate material. Such particulates would originate from haul-road traffic, drilling and blasting, digging and removing overburden and coal, crushing and loading, and wind erosion. The operation of diesel-powered equipment would also add exhaust gases to the air (VTN Colorado, 1975b). Assuming that land surfaces are successfully reclaimed, air pollution resulting from such mining activity should be a short-term phenomena; that is, it would occur only during the mining and land-reclamation processes. Lack of complete reclamation, specifically vegetative cover and erosion protection, could cause blowing dust to be a long-term problem.

F. Vegetation

The proposed use of the East Decker and North Extension areas for coal production would ultimately destroy approximately 4,000 to 5,000 acres of vegetation. At no time, however, would the entire mine areas be devoid of vegetation, inasmuch as areas on which mining was completed would be regraded, retopsoiled, and reseeded concurrent with the continuation of mining in other areas. (Sections 26-2.10(10)-S10310 and 26-2.10(10)-S10340 of the Rules and Regulations adopted pursuant to the Montana Strip and Underground Mine Reclamation Act). Given successful reclamation, the productivity of the East Decker and North Extension acreages should be interrupted only for the time required for mining to be completed and for permanent revegetation to occur. If reclamation is not successful on all or any part of the mined areas, then the long-term productivity of the vegetation resource will have been partially sacrificed for the short-term benefits that the coal resource provides.

Vegetation on areas that have been mined or utilized for roads or facilities would not return to a permanent, diverse cover within the near future (short-term) as a prolonged time period is required for succession to occur. Diversity is not necessarily a requirement for a productive vegetation resource, (e.g., monocultural croplands are not diverse). Diversity, however, is characteristic of the vegetation complex on permanent stable rangelands, a complex that is capable of growing and reproducing without man's inputs.

Species or communities requiring topo-edaphic conditions that are not duplicated by reclamation practices would be eliminated from reclaimed areas for a period considerably longer than the short-term; perhaps a period encompassing hundreds of years.

Increased human population in the Decker area is another short-term use of man's environment that may have long-term affects on vegetation productivity. Increased foot and vehicle travel on adjacent rangelands, if abusive, would result in long-term destruction to the soils resource in localized areas outside the mine boundaries, thus impairing vegetative productivity (see p. 457-458).

Dust from mine and mine-related activity could also affect the short-term productivity of vegetation outside the mine boundaries. Given successful reclamation of mined areas, dust impacts on vegetative productivity should not be long-term.

Existing rangeland within the proposed mine areas is badly overgrazed. Successful reclamation of the project areas, therefore, could result in the reestablishment of vegetation that would produce more energy for primary consumption (wildlife, cattle, man) than does the premining vegetation complex. A long-term gain in primary productivity as a result of reclamation would offset the short-term productivity declines that result from the mining of the two areas.

G. Wildlife

1. Mammals and birds

All species of wildlife utilizing areas that would be disturbed by mining activities would suffer at least short-term habitat losses. Human activity associated with the proposed mining operations would also impose some short-term impacts. For those species such as the white-tailed deer which can tolerate increased human activity and whose requirements would not be as severely affected by mining, impacts would probably not extend much past the cessation of mining. Species, such as antelope and sage grouse, which have very explicit habitat requirements and are intolerant of increased human activity, would be adversely affected for longer periods of time.

The maintenance of a productive wildlife resource in the two mining areas, of course, depends on successful reclamation. Specifically, the Montana Strip and Underground Mine Reclamation Act requires that the reclaimed vegetative cover "be capable of feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation" (Section 50-1045 R.C.M. 1947). If the proposed mines are indeed reclaimed to such a suitable, diverse cover, then the productivity of the wildlife resource on or adjacent to the premined areas should, in the long-run, not be diminished by strip mining. Time and additional reclamation research is needed, however, before conclusive statements can be made regarding the reclaimability of the Decker area (see section IV. B. 5.).

2. Fish

Although unlikely given Decker Coal Co.'s mining plan and accompanying mitigation measures, the present fishery resource in the Tongue River Reservoir could suffer short- or long-term declines in numbers and diversity as a direct result of mining in the proposed areas. The severity and duration of this decline would depend on the success of measures taken to decrease or eliminate sediment loads, turbidity, and chemical pollution contained in discharge from the pits and in surface-water and ground-water flow into the reservoir.

H. Land use, agriculture, and grazing

Agricultural land or other open space that is converted to urban uses would undergo, for all intent and purposes, a long-term change. If the two Decker mine proposals are approved, such losses would occur largely in the Sheridan area. Because the new mines represent a catalyst for growth, areas on the periphery of Sheridan would change from relatively undeveloped open space to more populated urban areas during the period for which the mines are active, and perhaps over the long term.

As the population of Sheridan grows, increased recreational demand on nearby lands would cause some reduction in the area's aesthetics, hunting quality, and wildlife diversity. Such changes would also occur in the short, as well as the long term, as it is assumed that coal production in southeastern Montana and northeastern Wyoming would continue long after the proposed mines have reached their limits.

In the proposed mine areas, the Decker Coal Co. would fence a total of approximately 6,040 acres, thus removing this area from agricultural production for the life of the mines. This would result directly in the loss of approximately 440 acres of irrigated cropland and the loss of an estimated 1,000 AUM's for at least the 20-year life of the projects. The total output of farms and ranches in the area would be reduced accordingly. This subsequent decline in total farm and ranch output would be minor, however, as 6,040 acres represents a projected decline in gross farm receipts of approximately $95,000 annually. This decline is approximately 0.4 percent of the reported total in Big Horn County during 1973 (Montana Department of Agriculture, 1974).

Undisturbed vegetation within the proposed mine boundaries would benefit in the long term from the short-term exclusion of domestic grazing. Furthermore, if reclamation of mine spoils is successful, agricultural and range productivity on revegetated areas should equal or exceed that which accrued from the largely overgrazed premining vegetative cover.

From a monetary stand point, short-term coal production from the proposed mine areas would provide considerably more income than would grazing or farming over the same time period. Given successful reclamation, (the key element in any discussion of short-term costs vs. long-term benefits), it would be possible for society to reap both the short-term benefits of increased coal production and the long-term benefits of a viable agricultural land base.

I. Social and economic environment

Assessments of trade-offs between short-term social losses and long-term social gains is a value judgement that varies from individual to individual. Regardless of one's biases, however, the short-term use of the Decker mine area for the production of coal would cause substantial long-term changes in the quality of life in Sheridan, Wyoming. Population density, traffic volumes, housing pressures, and administrative bureaucracies would increase while the small-town atmosphere and strong economic dependence on agriculture would decrease. The processes of attitudinal changes and acceptance of a new "status quo" occur slowly and are therefore long-term. To some small degree the socioeconomic differences between mine employees and ranchers or company officials and those who adhere to a skeptical or negative view of strip mining may never be resolved.

In the short term the existing small town atmosphere of Sheridan would give way to conflicts between old and new residents. New residents who have different traditions and values are likely to feel alienated from the existing social structure. In the long run, conflicts between old and new residents of Sheridan could be largely replaced by more urbanized styles and attitudes.

It is unlikely that Sheridan's long-term social-support facilities would be enhanced by the proposed Decker mine expansions inasmuch as the cost to the community would exceed its tax revenues. Big Horn County in Montana, on the other hand, would receive tax revenues in excess of its service costs and should, therefore, accrue a net social benefit from the short-term production of coal.

It is somewhat erroneous to view the proposed Decker mines, as a short-term project that provides only temporary economic benefits to the socioeconomic impact area. Twenty years of relatively certain production compares favorably with other forms of industrial development. The same degree of certainty could not be assigned to, for example, a new carpet mill, canning factory, or slaughter house. Many changes can occur over a fifth of a century. Almost no one predicted in 1955, for example, that agricultural jobs would decrease by almost one half by 1975. Similarly, very few persons anticipated the current situation in the tourist industry, dependent as it is on the uncertainties and increasingly expensive resources of fuel. In short, very few industrial developments carry with them assurances of long-term permanence. When compared with other industrial projects which are feasible for the socioeconomic impact area, coal mining then has many advantages.

In the long run both Montana and Wyoming might attract further industrial development inasmuch as the proposed East Decker and North Extension mines could serve as catalysts for such growth. Any increase in economic productivity in the socioeconomic impact area would include an increase in the ability of the surrounding area to attract further capital in the form of investments and retail spending. This trend should continue for a period beyond the economic life of the projects, given the socioeconomic impact area's potential for further coal production. In an economic sense then, the short-term use of the physical and biological environments provides a stimulus to maintain and enhance long-term economic productivity.

J. Archaeological and historical sites

Archaeological and historical sites or artifacts are nonrenewable and hence long-term resources. In the event that significant sites are not discovered and are destroyed during the mining process, the physical resource loss would be irretrievable. In addition to such a possible loss of physical resources, educational and scientific information regarding prehistoric environments and our cultural heritage would also be lost to both present and future generations.

K. Highways

The secondary road relocation proposed by the Decker Coal Co. would, when compared to the present highway, result in an additional 1.41 miles of travel between common points. This highway addition, when added to the new highway created because of Decker Coal Co.'s 1972 relocation, would total a 3-mile long-term increase in travel distance to the users of Route FAS 314.

Short-term decreases in air, water, and noise quality would be anticipated during highway construction. Unnoticed archaeological values, a long-term resource, may also be destroyed during construction.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

A. Coal

Coal mined in the East Decker and North Extension areas would be shipped to electric power-generation plants, burned, and thereby lost to future or other use. An estimated 180 million tons of coal would be mined under this proposal, which represent about 0.43 percent of the approximately 42 billion tons of coal in Montana that are recoverable by present (1974) surface-mining techniques.

B. Other minable minerals

An indeterminate amount of clinker and a small amount of gravel would be lost to future use as construction materials in the immediate area. The loss of the clinker is not significant because of the vast resources of these materials in the surrounding area. The gravel deposits are thin, have very limited areal extent, and contain sufficient fine-grained materials that they are of doubtful economic value.

C. Ground-water aquifers

Those parts of aquifers that are physically removed during mining would be lost to future use as separate and distinct hydrologic units. Adjacent undisturbed parts of these aquifers would be affected temporarily, but not permanently.

D. Stream valleys

Those stream valleys that are physically destroyed during mining would no longer exist as separate and distinct hydrologic and geomorphic units. Adjacent valley reaches extending upstream from the mined areas would be affected temporarily, but not permanently, provided that stable channels are constructed to carry flows over the highwall and into depressions left in the surface of the reclaimed mine areas.

E. Soils

Mixing of soil horizons, thus altering the existing natural soils and changing the physical, chemical, and biological characteristics that determine their productive capacity, cannot be avoided. Soil properties such as texture, structure, pH, SAR values, and organic-matter content would be irreversibly altered. If expected reclamation results are not obtained, some loss of productive capacity of the soils would be an irretrievable commitment of resources.

F. Vegetation

The proposed mining projects should cause few irretrievable commitments of vegetative resources, provided that reclamation as required by the Montana Strip and Underground Mine Reclamation Act is achieved in the long-run. Species or communities requiring topo-edaphic conditions that are not duplicated by reclamation practices would be lost for perhaps hundreds of years.

G. Wildlife

1. Mammals and birds

Most impacts to wildlife in the Decker area are short-term and would be mitigated if the area is reclaimed to the diverse vegetative cover that existed prior to mining. Inadequate or unsuccessful reclamation would reduce the quantity and quality of wildlife habitat available in the Decker area.

A decline in the antelope population is expected during the period of mining; the number lost and not ultimately replaced is dependent upon the success of reclamation.

Sage grouse in the East Decker mine area would continue to be adversely affected after mining is completed. Distruction of the strutting ground in the East Decker area could reduce the breeding activities of those grouse that have historically utilized this ground. Also sage grouse nesting areas would be lost as a result of mining disturbances in both project areas.

2. Fish

The fisheries of the Tongue River Reservoir could be negatively impacted in both the short- and long-term if mining at the proposed sites or related activities (i.e., the railroad spur) causes substantial changes in water quality and sediment load. The appraisal of the effects of mining on the water resources (section III. C. 3. a.) indicates, however, that such changes are not expected from the proposed operations.

H. Human and economic resources

The commitment of capital expenditures and human resources (time and labor) is irretrievable, but is beneficial because new employment opportunities would be created. Such commitments would be made at both the mine sites (largely by the city, county, and its residents).

The removal of 6,040 acres from agricultural production would reduce the total output of farms and ranches in Big Horn County. This irretrievable loss in gross farm receipts is optimistically projected to be about $95,000 (1970 dollars) per year for the 20-year life of the proposed Decker projects. The adverse economic impact of this action would be relatively minor, however, inasmuch as the 6,040 acres is only slightly larger than the average farm or ranch in the Decker area and the projected decline in gross farm receipts represents only about 0.4 percent of the reported total in Big Horn County during 1973 (Montana Department of Agriculture, 1974).

I. Land use

Conversion of agricultural land or other open space to urban uses is for all intent and purposes irretrievable. With regards to the two Decker mine proposals, such losses would occur largely in the Sheridan area. As coal development projected for northeastern Wyoming and southeastern Montana probably would continue long after termination of the two proposed Decker mining projects, the demand for expanded urban land usage on the fringes of Sheridan would be long term.

J. Archaeological and historical sites

Archaeological and historical resources are nonrenewable. In the event that significant sites are discovered and enforcement of regulations is inadequate, archaeological and historical resources could be irretrievably lost. In addition to the loss of physical resources, educational and scientific information regarding prehistoric environments and our natural and cultural heritage could also be lost (VTN Colorado, 1975a and 1975b).

K. Aesthetics

Loss of open space qualities and areas where man's influence has been minimal are becoming increasingly important in environmental decisions. For many people, any loss or degradation in aesthetic resources is an irreversible and irretrievable commitment of that resource. In a rapidly expanding, complex, technological world, areas of peace and tranquility have been recognized as valuable resources.

L. Energy, fuel, and materials

1. East Decker and North Extension sites

The strip mining of coal and reclamation of disturbed areas at the two proposed mine sites would require the use of electrical power, liquid fuels in the form of diesel fuel and gasoline, ammonium-nitrate-base explosives, and structural and repair materials (see p. 50 and 77). Diesel fuels would be used for powering mobile equipment and for use with ammonium-nitrate prills; structural and repair materials would be needed for mining equipment and for use in the shops. Approximately 40,300,000 kilowatt hours of electricity, 1,730,000 gallons of diesel fuel, 165,000 gallons of gasoline, and 16.2 million pounds of ammonium nitrate would be consumed annually at the proposed mines and would be irretrievably lost for other uses. In addition to power, fuel, and explosives, an unquantifiable amount of chemicals and materials used in the mining and subsequent reclamation processes would also be irretrievably lost for other uses.

2. Highways

Construction of Decker Coal Co.'s proposed realignment of Route FAS 314 would not be expected to significantly increase traffic volumes or traffic routing patterns. For this reason, a discussion of traffic fuel consumption has not been included.

The Montana Department of Highways estimates that the following petroleum based products would be consumed in the construction of the Decker Coal Co.'s proposed Route FAS 314 realignment:

No. 2 diesel = 70,000 gal
Gasoline = 10,000 gal
Asphalt = 1,100 tons

VIII. ALTERNATIVES TO THE PROPOSED ACTION

A. Introduction

The Decker Coal Co. has made separate applications, as required, to both the Secretary of the Interior and the Commissioner, Montana Department of State Lands for permission to mine coal in the East Decker and North Extension mine areas under the proposals evaluated herein. Most of the coal that would be mined is federally owned and has been leased to the Decker Coal Co., which holds title to most of the land surface. Less than 25 percent of the coal to be mined is State owned. Most of the land surface overlying State coal is owned by the State.

Given the existing dual regulatory and approval authority regarding the present proposals, the viable and reasonable alternative courses of action available to the two authorities for the two mine proposals differ significantly. The following discussion of alternatives recognizes the individual responsibilities of the Federal and State governments and attempts to analyze the environmental consequences of the various alternatives available to the Secretary of the Interior and to the State authorities.

Alternatives that apply generally to the development of the coal resources in the Decker area, Montana, include those of an administrative nature as well as those involving alternate mining and reclamation plans, technological alternatives, and reduced consumption of energy or development of alternative sources of energy.

B. Administrative alternatives available to the Secretary of the Interior

1. Mining and reclamation plans

a. No action

Pursuant to implied covenants of both the Federal mineral leasing laws and the existing lease agreements, the Secretary is obligated to respond to a legitimate application to conduct mining operations on a valid lease, provided that all terms and conditions thereunder have been met. His response may be approval as proposed, rejection on various legitimate grounds, approval in part and rejection in part, or approval subject to such additional conditions and requirements as he may impose under the laws. He may also defer decision, based on proper grounds, as described elsewhere in this chapter.

"No action" on proposals for continuation of approved ongoing mining operations would equate to closing down existing operations; under existing regulations, operations may not proceed in the absence of approved mining plans and related permits. The impacts of taking no action in such cases would be approximately the same as those described under the following subsection c. (2), "Cancel the leases."

"No action" on mining proposals for the initial development of existing leases would equate to maintaining the status quo on those leases. The impacts of taking no action in these cases would be the same as described subsequently under subsection c., "Prevent further development on existing leases."

b. Defer action

For proper cause, the Secretary may defer final action on a proposed mining and reclamation plan. These could include, but are not limited to, the need and time required for:

1. Modification of the proposal to correct administrative or technologic deficiencies.
2. Redesign to reduce or avoid environmental impact.
3. Acquisition of additional data to provide an improved basis for technical or environmental evaluation.

4. Further evaluation of the proposal and/or alternatives.

The principal effect of deferring action on a proposed mining and reclamation plan on these grounds would be a comparatively short-term delay in the imposition of all related impacts of the proposal--both adverse and beneficial, as previously described in section V. of this statement. For example, the adverse socioeconomic impacts of the proposed action in the Decker area would be borne by Wyoming, principally by the city and county of Sheridan, whereas the revenues would accrue to Montana (see p. 477-479). Authorization for further development in the Decker area could be deferred until this problem is adequately resolved (see sections IV. C. 4 and IV. C. 5).

Once a mining and reclamation plan is approved, the regulations and lease terms require that all subsequently proposed departures and deviations therefrom be approved in advance by the USGS. The regulations also permit (30 C.F.R. 211) the USGS to direct that changes be made in previously approved operations. For example, changes could be ordered to accommodate new, improved, or revised administrative requirements, technologic improvements, environmental concerns or requirements, or revisions of prior evaluations thereof in the light of experience or previously unknown factors. Such changes have been ordered routinely in USGS mining supervision practice.

c. Prevent further development on existing leases

The only alternatives to allowing development of existing leases is to prevent such development or to impose additional conditions and restrictions on the operations. The several apparent means of preventing full development are discussed below.

If prevention of further development of existing leases were accomplished, substantial quantities of coal known to be present would be left in place and not recovered for use. To replace the resources foregone by this alternative course of action, other comparable quantities of coal or sources of energy would be required to meet national needs. The development of other sources and related impacts are discussed later.

(1) Suspend operations

The full development of existing leases could be delayed by suspension of operations. If such action were taken, there would be no additional incremental environmental impact on the area, and it would continue in its present condition, subject to further modification by natural processes, the continuation of existing mining activity, and such future uses of the surface as the owners may decide.

The authority of the Secretary of the Interior to suspend operations on existing leases has already been utilized, and future suspensions of operations in southeastern Montana for reasonable periods, with proper grounds, could be imposed. The Secretary cannot, under present circumstances, suspend operations to the extent that a de facto cancellation of a lease results unless he seeks and obtains additional authority from Congress. Viability of this option is dependent upon timely legislature action; the option of suspending operations pending legislation remains available. Impacts of this alternative would be similar to those described in subsection c. (2), "Cancel the leases."

(2) Cancel the leases (No new development)

The Secretary does not possess authority to unilaterally cancel the leases except on the grounds defined therein (section 7 or 8 of the lease terms--"Proceedings in case of default"). The authority to cancel on other grounds would require Congressional authorization for such action as well as for the requisite funds for compensation of the lessees as may be necessary. The Administration has not entered a request for such legislation, and the Congress has not initiated such action in the matters considered in this statement. The possibility of such actions is a matter for further consideration by the Administration and the Congress in the light of this environmental statement and other relevant non-environmental concerns.

Present production could be interrupted temporarily or terminated completely, as could further development of all existing leases.

To the extent that coal production from existing leases was curtailed or halted, alternative sources of energy would be required to meet present needs and demands. These could be foreign and/or domestic and are discussed on later pages. The time required to replace the resource foregone could range from scant to a number of years, depending on the specific alternative(s) selected and its state of production.

Environmental impacts of the proposals could range widely, depending on the administrative action taken on existing leases. If these leases were cancelled through Congressional authorization, all physical, aesthetic and socioeconomic impacts stemming from the proposed mines would be avoided. Conversely, should development eventually be authorized, environmental impacts as discussed (chapters III and VIII) would occur. The net result would be a deferral and perhaps reduction of impacts through changed technology or requirements imposed at that time.

(3) Federal acquisition of leases

The outstanding leasehold interests could be acquired by the Secretary. The ability to acquire the leasehold interests is not granted by the existing relevant statutes and would require Congressional authorization for such action as well as for the requisite funds for compensation of the lessees. To date, the Administration has not requested such action, and the Congress has not initiated or considered such legislation; the possibility thereof is thus conjectural at best. The major effects of such Congressional authorization would be similar to those of cancellation of the leases as previously discussed under subsection c. (2).

(4) Reject the mining and reclamation plans

Rejection of the proposed mining and reclamation plans would result in no environmental impact on the leased lands, and they would continue in their present condition, subject to modification by natural processes and by the continuation of other existing activity and uses--and to further modification by the surface owner to meet other uses.

The Secretary may reject any individual proposal activity that does not meet the prescriptions of applicable law and regulations under his authority, including the potential for environmental impact that could be reduced or avoided by adoption of a significantly different designed course of action by the lessee (operator). Except when a mine plan does not comply with existing regulations, the Secretary cannot under present circumstances reject the proposed plans to the extent that a de facto cancellation of a lease results unless he seeks and obtains additional authority from Congress. Viability of this option is dependent upon timely legislature action; the option of rejecting the proposed plans pending legislation remains available. Impacts of this alternative would be similar to those described under subsection c. (2), "Cancel the leases."

d. Restrict development on existing leases

The subject leases convey the right to develop, produce, and market the Federal coal resource thereon if all other terms and conditions have been met by the lessee. In general, the Secretary does not possess the authority to arbitrarily constrict development. Various measures that may tend to restrict development may be taken by the Secretary at any time in the interest of conservation of the resources or in the protection of various specific environmental values in accordance with existing laws and regulations; for example, the National Historic Preservation Act of 1966, the Endangered Species Act of 1973, etc.

Thus, under present conditions, a general effort to restrict or regulate development of existing leases for reasons other than failure to comply with existing laws and regulations would constitute a selective application of the "prevent development" alternative already discussed; that decision, as it relates to impacts, possible litigation, and the need for authorizing legislation, would be relevant in this instance.

e. Approve the mining plan after modification

A number of the impacts identified and described in section III of this statement could be more fully mitigated by the selective application of those measures described in section IV that are supplemental to the proposals of the Decker Coal Co. or by implementation of one or more of the alternatives described below. In addition, special conditions could be added to the approved plans relating to the secondary effects of mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the East Decker and/or the North Extension areas with the resultant impacts previously discussed under subsection c. (4) "Reject the mining and reclamation plans."

f. Allow development of selected areas now under lease

This alternative would permit only selective exploration and development of existing leaseholds, based on anticipated adverse environmental consequences. The decision maker has the authority and responsibility to evaluate the coal resources and impacts of mining on these leases prior to acting on the proposals. Exploration and development could be allowed only on those leaseholds, or portions thereof, that would have the lowest anticipated adverse environmental consequences. Weighing the tradeoffs of mining or precluding mining on selected tracts is part of the evaluation and decision process. Adoption of this alternative would reduce adverse effects by reducing the area in which the impacting activities could take place.

The alternative of allowing the development of only selected areas already under lease constitutes a selective application of the alternative of preventing further development of existing leases described above. Absent a showing lease-by-lease or plan-by-plan of the likelihood of wholly unacceptable environmental impacts that could not be reduced to an acceptable level, the Secretary does not possess the authority to otherwise constrain development of the leasehold if all other requirements of the lease have been met. In addition, application of this alternative would not permit maximum recovery of the coal resources and would thus be contrary to principles of conservation embodied in the legislation which authorizes the leasing of these lands for the purposes described. It is entirely possible that such selective mining would leave isolated blocks of coal that might never be recovered owing to the high costs of mining such remnant areas at a later date.

g. Refuse to issue additional Federal leases now under application for the expansion of the North Extension mine

Under existing law, any action to offer additional coal for leasing is a matter of the Secretary's discretion. If no further offerings are made, the impacts of existing mining operations would continue through the life of the approved operations. These impacts would increase incrementally as described herein to the extent that further exploration, development, and production operations on existing leases were proposed and approved. Unleased coal resources on land lying between the lease boundaries of the North Extension area and the Tongue River Reservoir in sec. 34, T. 8 S., R. 40 E., and sec. 3, T. 9 S., R. 40 E. (fig. 1), would not be developed in conjunction with Decker Coal Co. operations. If so, these isolated blocks of coal might never be recovered.

Should the Secretary determine that the potential coal resources under application on presently unleased areas in sections 3 and 34 are such that, on balance of all appropriate considerations, they may warrant leasing and development, the established leasing activities of the Department would be initiated.

C. Administrative alternatives available to State Agencies

1. Department of State Lands

a. Refusal of permit under the Montana Strip and Underground Mine Reclamation Act

Under Section 50-1042(1), R.C.M. 1947, the Department of State Lands may not approve an application for a strip mining permit if "there is found on the basis of the information set forth in the application, an on-site inspection, and an evaluation of the operation by the Department that the requirements of the act or rules will not be observed or that the proposed method of operation, backfilling, grading, subsidence stabilization, water control, highwall reduction, topsoiling, revegetation, or reclamation of the affected area cannot be carried out consistent with the purpose of this act."

b. Refusal of permit as to certain lands included within application for permit under the Montana Strip and Underground Mine Reclamation Act

Under Section 50-1042(2), R.C.M. 1947, the Department of State Lands may not approve an application for a strip-mining permit where the application includes lands having special, exceptional, critical, or unique characteristics, or where mining on the area would adversely affect the use, enjoyment, or fundamental character of neighboring land having special, exceptional, critical, or unique characteristics. Under Section 50-1042(3), R.C.M. 1947, the Department must delete from a permit lands with overburden such that "experience in the state with a similar type of operation upon land with similar overburden shows that substantial deposition of sediment in streambeds, subsidence, landslides, or water pollution cannot feasibly be prevented***" Section 50-1042(4), R.C.M. 1947, provides that if the Department finds that the operation proposed would constitute a hazard to a dwelling house, public building, school, church, cemetary, commercial or institutional building, public road, stream, lake, or other public property, it must delete those areas causing the hazard from the permit.

c. Approval of a modified mine and reclamation plan for lands included within an application for permit under the Montana Strip and Underground Reclamation Act

The Department of State Lands may approve mining and reclamation plan modifications that meet the requirements of Montana Strip and Underground Mine Reclamation Act or the Department's rules adopted pursuant to the Act. During the period since the submittals of surface-mine permit applications for the East Decker and North Extension proposals, many meetings and exchanges of correspondence have occurred between the Department and the Decker Coal Co. in which the Department's and the Company's concerns relative to the initial plans were discussed. As a result of such concerns, the Company has submitted modifications to their original mining and reclamation plans to the Department. These modifications and an analysis of the respective environmental impacts are discussed in sections VIII. D, VIII. E, and VIII. F. The Department will continue to analyze the most promising of these modifications, but can approve only the most suitable plan for each area.

d. Disapproval of strip-mining plan under the Montana Strip Mined Coal Conservation Act

After a strip-mining plan is submitted to the Department under the Strip Mined Coal Conservation Act, the Department has six months to review the plan to determine whether waste, as defined in the act, would occur. If so, the plan must be disapproved, otherwise it is approved. If the Department fails to make the required determination within six months, the plan is deemed approved. If a plan is disapproved, the Department must recommend means by which to bring the plan into conformance with the Act.

2. Montana Highway Commission

a. Modification or disapproval of relocation of Federal-aid secondary highway

State approval, disapproval, or modification of the secondary highway relocation rests with the Montana Highway Commission and the Director, Department of Highways. Because Federal-aid Secondary Route 314 is presently maintained as part of the secondary system by Big Horn County, the applicant must first request the relocation as a change in the secondary highway system of that county. Upon approval or modification of that request, the county would submit the request to the Director and the Highway Commission. Following their action, the Montana Division of the Federal Highway Administration, U.S. Department of Transportation, must also approve the system change. While no action would be taken by the Department of Highways until a decision is rendered on the mining-permit application, interagency coordination relating the relocation alternatives to the applicants permitted mining and reclamation plan is necessary.

3. Department of Health and Environmental Sciences

a. Approval of a construction permit for coal-handling facilities under the Montana Clean Air Act

The Department of Health and Environmental Sciences may approve designs for the East Decker coal-handling facilities as submitted by the Decker Coal Co. Such approval would indicate that the Department considers the designs for the construction of coal-crushing, storage, and loadout structures to be consistent with installation of the best available control technology for preventing and abating air pollution. The Department may also approve an operating permit for the East Decker coal-handling facilities after construction has been completed, provided the facilities are built in accordance with the approved design specifications.

b. Approval after appropriate design modification of a construction permit for coal-handling facilities under the Montana Clean Air Act

The Department of Health and Environmental Sciences may approve designs submitted by the Decker Coal Co. for the construction of the East Decker coal-handling facilities after appropriate modifications. Such approval would indicate that the Department considers the modified designs for the construction of the coal-crushing, storage, and loadout structures to be consistent with installation of the best available control technology for preventing and abating air pollution. The Department may also approve an operating permit for the East Decker coal-handling facilities after construction has been completed, provided the facilities are built in accordance with the approved modified design specifications.

c. Disapproval of a construction permit for coal-handling facilities under the Montana Clean Air Act

The Department of Health and Environmental Sciences may disapprove the designs for coal-handling facilities as submitted by the Decker Coal Co. Such disapproval would indicate that the Department does not consider the proposed designs for the coal-crushing, storage, and loadout structures to be consistent with the installation of the best available control technologies for the prevention and abatement of air pollution. Such disapproval also would indicate that the Decker Coal Co. is unwilling or unable to construct coal-handling facilities that would meet established emission standards, emission limitations, and/or ambient air-quality standards.

D. Alternate Mining Plan A for the East Decker area

1. Background

On October 10, 1975, the Decker Coal Co. submitted to the U.S. Geological Survey and to the Montana Department of State Lands an alternate mining and reclamation plan for the East Decker area. This alternate plan, which is referred to as Alternate Mining Plan A, would cover only the mining of coal held under State and fee leases and would exclude from mining all coal held under Federal lease, Montana 073093 (fig. 1). The plan was prepared to enable the Decker Coal Co. to partially meet their contractural obligations in the event that legal restraints stemming from the "Kleppe v. Sierra Club" suit or other similar actions would prevent or delay the mining of Federal coal in this area. Although the U.S. Supreme Court decided the "Kleppe v. Sierra" Club suit in favor of the Department of the Interior, Decker Coal Co. requested that Alternate Plan A still be included in the impact statement.

The principal differences between the alternate plan and the original proposal are in the amount of coal to be mined, the mining sequence, the recontoured topography, the water-diversion system, and the county-road relocation. The alternate plan would mine about 444 acres or about 18 percent of the area that would be mined under the original proposal. The plant area and related facilities would be the same as under the original proposal.

2. Description of the proposals

a. Description of the coal

An estimated 20 million tons of coal, about 4 million tons per year, would be mined in the East Decker area under Alternate Plan A.

The coal is contained in the Anderson, Dietz 1 and Dietz 2 beds described previously (p. 26 and fig. 4.) Initial production would be from the Dietz 1 bed where it is exposed in scraper pits. The Dietz 1 and Dietz 2 beds would be mined in the initial dragline turnover cuts, and all three beds would be mined beginning with the fourth turnover cut and continuing through the final or 21st cut.

b. Mining sequence and procedures

Two scraper pits would be excavated initially, one adjacent to the railroad loop and the other farther southwest, adjacent to the railroad spur (fig. 73). Overburden from these pits would be moved by scrapers and used for fill in the railroad loop and plant area (4 million cubic yards) and for construction of the railroad and access road embankments (3 million cubic yards). A box cut excavated by dragline along the northern edge of the mine area would extend eastward from the loop scraper pit to the northeastern boundary of the mine.

The use of scrapers to remove the overburden from an area averaging about 450 feet wide adjacent to the railroad (fig. 73) would, after recovery of the exposed Dietz 1 coal, provide the additional space necessary for placement of the large volume of overburden spoils excavated from the dragline box cut to the Dietz 2 coal on the first turnover cut. This approach would enable the recovery of about 5 million tons of coal that would not be mined under the original proposal.

Overburden removal as mining proceeds southward and eastward (fig. 73) would be essentially the same as described on pages 33-37 and depicted on fig. 8. This mining sequence would allow continuation of mining activities onto the adjacent Federal lease with minimal interruption,

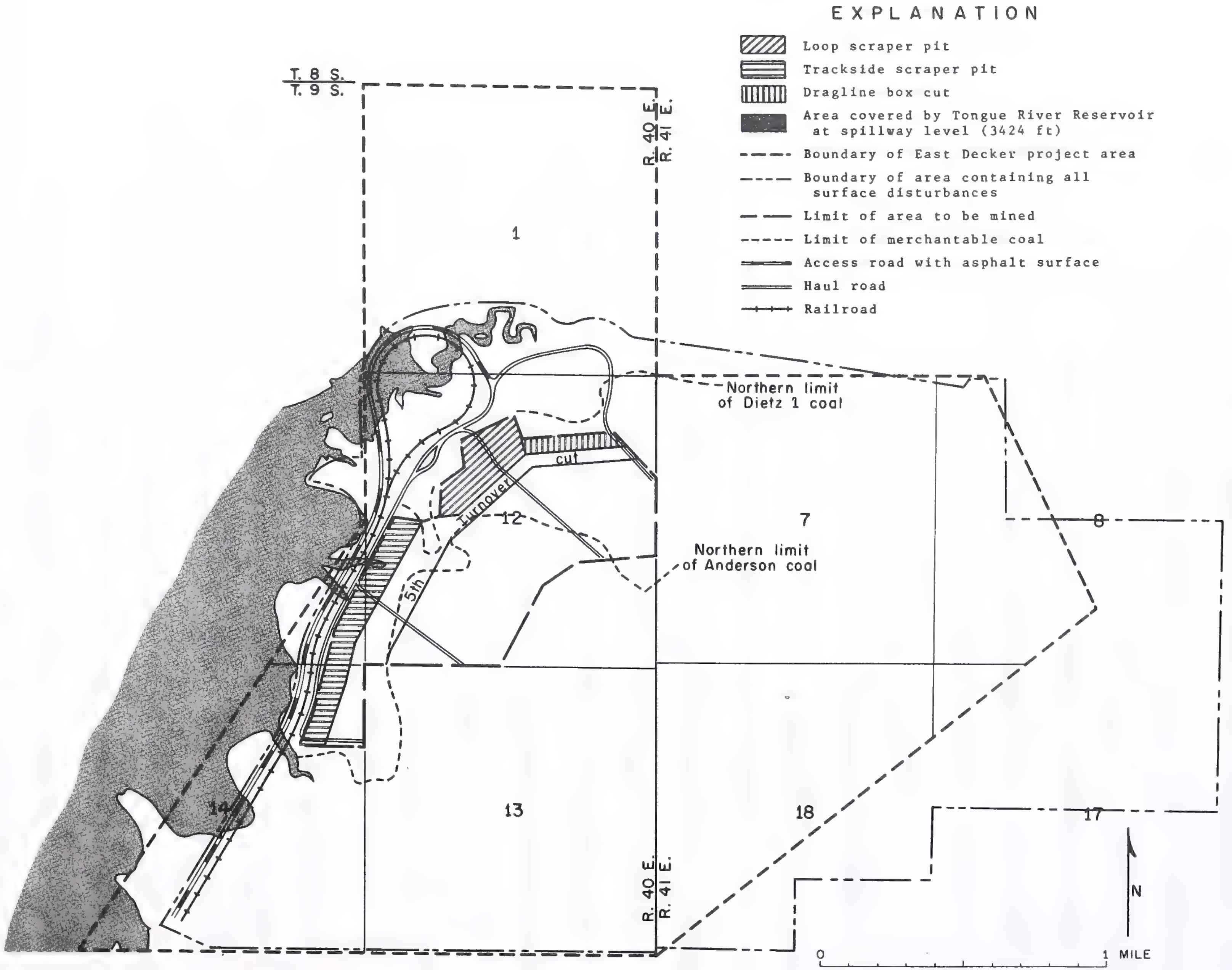

EXPLANATION
Loop scraper pit
Trackside scraper pit
Dragline box cut
Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of East Decker project area
Boundary of area containing all surface disturbances
Limit of area to be mined
Limit of merchantable coal
Access road with asphalt surface
Haul road
Railroad
T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
1
7
8
12
13
14
17
18
Northern limit of Dietz 1 coal
Northern limit of Anderson coal
cut
Turnover
5th
N
0
1 MILE

Figure 73.— Mining sequence and location of roads in the East Decker area under Alternate Plan A.

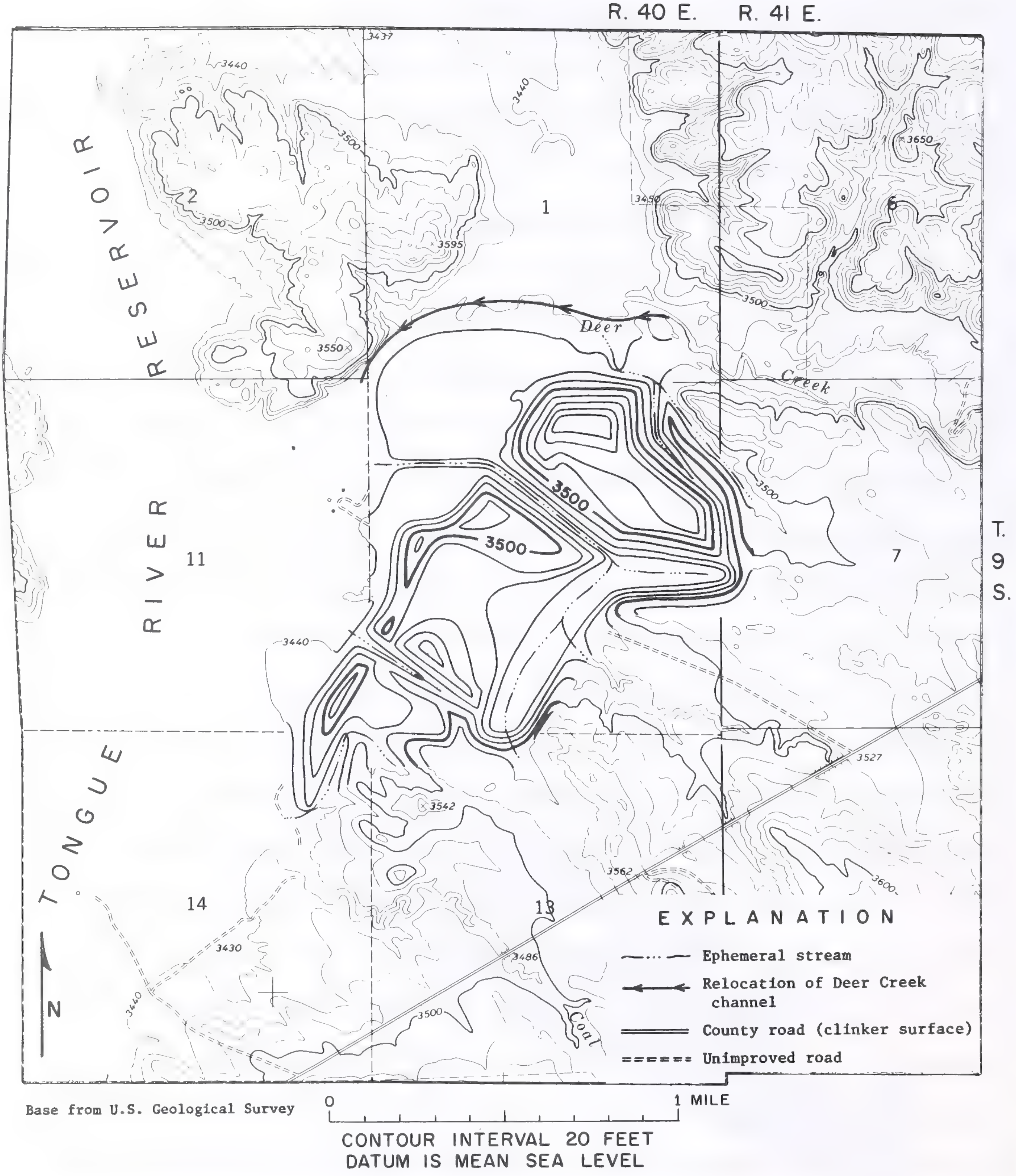
should a permit to mine the Federal coal be obtained at a later date. Mining and reclamation procedures would be essentially the same as those described under the original proposal, except for the reclaimed topography and the water-diversion system.

(1) Reclaimed topography

The proposed topography after mining is shown in figure 74. The final highwall would be reduced to a 20° (36 percent) or less grade and sloped toward the final pit to form a broad, northeast- to east-trending depression that would drain northwestward along a reclaimed haul-road corridor. The land surface would rise northward and westward from the final pit with the highest elevations occurring near the northwest margin of the mine area in the vicinity of the initial scraper pits and box cut. The maximum difference in elevation within the mined area would be about 150 feet.

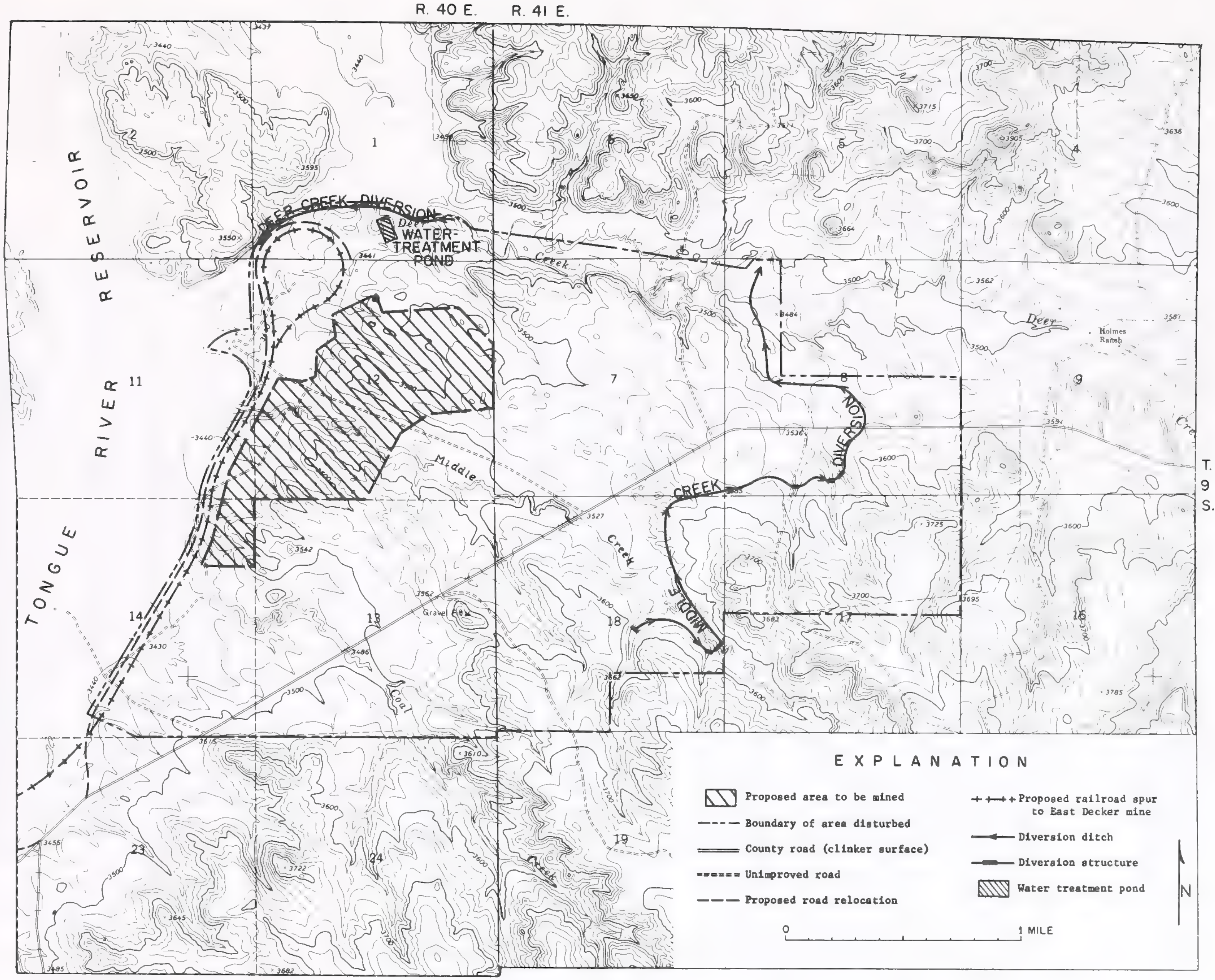
(2) Water diversion and impoundment

Alternate Plan A would not require the impoundment and diversion of Deer Creek as proposed in the original mining plan. Instead, Deer Creek would be routed through a channel constructed along the north side of the present valley where the stream would not contact spoils excavated from the initial box cut (fig. 74). The new channel would drain around the north side of the railroad loop and enter the same bay of the Tongue River Reservoir as does the present channel. Design specifications for this new channel would be the same as those for the diversion described in the original proposal (p. 41). Middle Creek would be intercepted and diverted as described in the original proposal (p. 41-43). Coal Creek would not enter the proposed mine area (fig. 75), and, therefore, the



Base from U.S. Geological Survey

Figure 74.—Proposed topography and drainage after mining under Alternate Plan A in the East Decker area.



Base from U.S. Geological Survey

Figure 75. – Proposed water-diversion system, access road, and railroad spur for Alternate Mining Plan A in the East Decker area.

channel would not be diverted or altered. Culverts that would pass 1,000 ft^3/s would be installed to carry flows in Coal Creek under the railroad fill.

On termination of mining, the Middle Creek diversion would be removed and the surface area restored. Middle Creek would drain through depressions in the reclaimed spoils to the Tongue River Reservoir. Deer Creek would permanently remain in its relocated channel.

Surface runoff within the mine area and ground water entering the active pit would be pumped into two treatment ponds, one east of the shop facilities would discharge into Deer Creek, and one at the southwest corner of the mine area would discharge directly into the Tongue River Reservoir. Outflow from each pond would be through a buried 8-inch diameter pipe. The exact location of the pond at the southwest corner of the mine area has not been selected pending final location of the railroad and access road to the mine.

c. Mining facilities and equipment

Mining facilities and equipment would be essentially the same as for the original proposal, except that Alternate Plan A would not require relocation of any part of the existing county road.

3. Description of the environment

The existing environment in the East Decker area is described in section II.

4. Environmental impacts of the proposals

Adoption of Alternate Mining Plan A would result in the mining of 82 percent less area than would be mined under the original proposal.

The effect generally would be a large, although probably not proportionate, reduction in environmental impacts.

a. Topography

The proposed reclaimed surface would be generally similar to that in the original proposal, except that a smaller area would be disturbed. Dominant features of the reclaimed topography (fig. 74) would be (1) an elongate dissected ridge along the northwest margin of the mined area, (2) an elongate depression along the southeast margin of the mined area, and (3) two essentially straight, northwest-trending "valleys" aligned along reclaimed haul-road depressions.

The impacts of the proposed Alternate Mining Plan A on topography are the same as those described under the original proposal for the East Decker area (p. 316), only to a lesser degree because of the smaller area that would be disturbed. The primary effect would be to create a potentially unstable, eroding surface that would not approximately restore the original surface configuration.

b. Soils

Mining in the East Decker area under Alternate Plan A would result in the disturbance and mixing of the topsoil on approximately 850 to 1,000 acres, or about 60 percent less area than would be disturbed under the original proposal. Impacts on soils would be similar in all respects to those described for the original proposal. Their magnitude, however, would be reduced by approximately 60 percent in keeping with the smaller area to be disturbed.

c. Water resources

(1) Effects on ground water

The impacts on ground water stemming from implementation of Alternate Mining Plan A in the East Decker area would be similar in most respects to those described for the original proposal. Significant modifications, however, would result from (1) the reduction in size of the area to be mined, (2) the relocation of the western boundary of the mine closer to the Tongue River Reservoir, and (3) the use of scrapers to excavate and move a significant amount of the overburden. These modifications are described in relation to the impacts of the original proposal.

(a) Removal of aquifers

Alternate Mining Plan A for the East Decker area would reduce substantially the size of the area in which aquifers would be removed during mining. The aquifers and approximate area from which they would be removed are as follows:

Aquifer	Approximate area to be removed (mi^2)
Anderson coal	0.25
Dietz 1 coal	.75
Dietz 2 coal	.75
Sandstone	$<.25$
Clinker	$<.50$
Alluvium	$<.25$

Removal of these aquifers would be accompanied by replacement of spoil materials in the mined-out area. Spoil materials in the western part of the area would be excavated by scrapers, but the scraper pits and successive turnover cuts (fig. 73) would be filled by dragline laid spoils. The permeability of these materials should be significantly greater than the permeability of the original aquifers.

(b) Interruption of ground-water flow by the pit

Reduction in the length of the western limb of the pit and virtual elimination of the northern limb under Alternate Mining Plan A would significantly reduce ground-water inflow to the mine. Without the northern limb, little or no inflow would occur from underflow in alluvium in Deer Creek valley or from ground-water storage in the clinker that underlies the surface throughout much of secs. 7 and 8, T. 9 S., R. 41 E. Similarly, reduction in the length of the western limb would tend to reduce inflow to the mine from the reservoir. Conversely, relocation of the initial cut about 600 feet closer to the Tongue River Reservoir would tend to increase ground-water inflow to the mine from the reservoir. The net effect of these changes probably would be to reduce inflow to the mine by as much as 0.5 ft^3/s. Estimated inflow one year after completion of the initial cut under Alternate Plan A would be 1.5 to 2.5 ft^3/s.

(c) Modifications of ground-water flow by replaced spoil materials

Under Alternate Plan A, the initial cut would be made by scrapers and the excavated spoils materials would be used for construction of road and railroad embankments and fill in the plant area. Thereafter, the initial cut and successive cuts would be filled by dragline-laid spoils, which should be moderately permeable (p. 322). The effect of these spoils on ground-water flow should be similar to that described under the original proposal. If so, inflow from the reservoir would not be reduced more than 25 to 50 percent. Because of the much smaller volume of spoil materials that would be generated under Alternate Plan A compared to the original proposal and the comparatively small reduction in ground-water inflow to the mine, it probably would take less than 5 years to saturate these materials after mining is completed. Thereafter, ground-water discharge across the mined-out area toward the Tongue River Reservoir should resume and increase rapidly to essentially the premining rate.

(d) Changes in water quality caused by leaching of spoil materials

Changes in water quality within the mine area as a result of mining under Alternate Plan A should be essentially the same as those described for the original proposal (p. 329). Ground water in the spoils aquifer probably would contain somewhat more than 4,000 mg/1 dissolved solids and would have a sodium adsorption ratio in excess of 50. Dominant ions probably would be sodium and sulfate. Because of the smaller area disturbed, discharge from the mine area to the Tongue River Reservoir both during and after mining should be somewhat less than under the original proposal. The adverse impact on the quality of water in the reservoir both during and after mining, therefore, should be so small as to be unmeasurable by standard methods.

(e) Effects of blasting

The reduction in the size of the area to be mined would ultimately lessen the number of shock waves to be generated by blasting. This should diminish the incidence of turbidity in nearby wells and reduce the probability of anomalous concentrations of nitrate in the mine effluent.

(f) Changes in water levels

Dewatering of the active pit would lower water levels in the adjacent area. Because of the much smaller area disturbed, however, a correspondingly smaller surrounding area would be impacted. Hence, fewer wells would be adversely affected.

The following five wells lie within the area that probably would be affected by water-level changes.

No.[1/]	Location T., R., section	Owner
52	9 S., 40 E., 11 ADAB	Decker Coal Co.
53	9 S., 40 E., 11 ADAC	Decker Coal Co.
54	9 S., 40 E., 13 CAAA	Decker Coal Co.
79	9 S., 41 E., 7 ADCA	Decker Coal Co.
80[2/]	9 S., 41 E., 7 CCBD	Decker Coal Co.

[1/] Sequential number of well (see listing in table D-1, Appendix D).

[2/] Well not used.

None of these wells lie within the mine area and, therefore, none would be destroyed. Two (nos. 52 and 53) are adjacent to the Tongue River Reservoir and probably would be minimally affected. Two others (nos. 54 and 79) are more than half a mile from the boundary of the area to be mined and also should be only minimally affected. The remaining well (no. 80) lies within the area where water level declines due to mining could seriously impair the use of the well.

(2) Effects on surface water

The impacts on surface water stemming from implementation of Alternate Plan A in the East Decker area would be generally similar to those described for the original proposal, but on a much smaller scale. The principal differences lie in (1) the smaller area to be mined, (2) alteration or removal of fewer existing stream channels, (3) construction of fewer diversion impoundments and channels, (4) a reduction in loss of water to the Tongue River Reservoir, (5) less degradation of water quality in the Tongue River Reservoir, and (6) fewer problems related to erosion and sedimentation.

(a) Removal of existing stream channels

Mining of 82 percent less area under Alternate Plan A than under the original proposal would require the alteration or removal of about 66 percent fewer natural stream channels. The channels and approximate length that would be altered or removed are as follows:

		Length of valley to be disturbed (miles)	
Stream channel	Type of disturbance	Under original proposal	Under Alternate Plan A
Deer Creek	Channel to be filled locally with spoils	2.1	1.6
Middle Creek	Channel to be removed	1.7	.7
Coal Creek	Channel to be removed	1.1	0
Other unnamed streams	Channel to be removed	9.2	2.5

Impacts from the alteration or removal of these channels would be similar to those described for the original proposal; the magnitude of the impacts would be significantly decreased, however, because of the disturbance of fewer channel reaches.

(b) Interception and diversion of runoff

No diversion impoundment or dam would be constructed on Deer Creek under Alternate Plan A. Construction of the railroad loop and a water-treatment pond in the lower reach of Deer Creek valley, however, would require relocation of the channel so that flows would be diverted around these facilities. The essentially straight diversion channel, as shown on figure 74, would have a length of about a mile and would replace about 1.6 miles of natural channel. The diversion channel, therefore, would probably have a slope about 1.6 times that of the natural channel or about 0.005. Channel erosion and possible headcutting would occur unless the increased slope is compensated for by armoring the diversion channel or by appropriate changes in other channel parameters that affect flow velocities.

The Middle Creek diversion system would be the same as under the original proposal; thus, impacts stemming from this part of the system would be the same. Conversely, the Coal Creek diversion system would be eliminated under Alternate Plan A, thereby eliminating any impacts stemming from that part of the system.

(c) Changes in quantity of water

Because of the much smaller area to be mined and elimination of the Coal Creek diversion system, loss of water to the Tongue River Reservoir under Alternate Plan A should be less than half the amount that would be lost under the original plan. It is estimated that mining in the East Decker area under Alternate Plan A would reduce total runoff to the reservoir by a maximum of about 50 acre-feet annually during mining and by a maximum of about 25 acre-feet annually after mining. This loss of water to the reservoir represents less than two-hundredths of 1 percent of total annual inflow to the reservoir during the period of mining and less than one-hundredth of 1 percent after mining.

Standing pools of water in the lower reaches of Middle Creek would be eliminated as under the original proposal. Standing pools of water in the lower reaches of Coal Creek, however, should not be adversely affected.

(d) Changes in chemical quality of water

Because of the much smaller area to be mined, correspondingly less water should infiltrate the surface and leach the spoils materials, both during and after mining. Surface runoff diverted around the mine area should undergo little or no change in chemical quality. Disposal of waste water from the plant area would be the same as under the original proposal and should generate no additional impacts.

(e) Erosion and sedimentation

Elements of Alternate Mining Plan A affecting erosion and sedimentation in the East Decker area that differ significantly from the original proposal are: (1) Disturbance of a much smaller area, (2) elimination of the Deer Creek and Coal Creek diversion systems and sediment settling ponds as proposed and construction instead of a comparatively short diversion channel in the lower reach of Deer Creek valley, (3) placement of fewer box-cut spoils in Deer Creek valley, and (4) changes in the areas of sediment accumulation in the Tongue River Reservoir. Impacts stemming from these changes are as follows.

The disturbance of a much smaller area generally would result in a corresponding reduction in area of restored surface, length of haul roads, length of disturbed channels, size and complexity of the diversion system, and road relocations. The effect would be to significantly reduce erosion and sedimentation in comparison to mining under the original proposal.

Elimination of the Deer Creek and Coal Creek diversions would prevent possible impacts stemming from construction of the diversions, erosion of diversion channels, deposition within and upstream from diversion impoundments, construction and maintenance of sediment settling ponds, and ultimate failure of the Deer Creek diversion system. Construction of the diversion channel in the lower reach of Deer Creek valley to carry runoff around the railroad loop could cause local channel scour and might initiate headcutting that could migrate upvalley.

Placement of a smaller volume of box-cut spoils in Deer Creek valley would reduce accordingly the extent of probably future erosion of these materials by Deer Creek and the deposition of the sediments thus obtained in the Tongue River Reservoir.

Elimination of the Deer Creek and Coal Creek diversions described in the original proposal would prevent the discharge of sediment to the reservoir at the outlets of these diversions. Coal Creek and Deer Creek would enter the reservoir at their present locations. During mining, Middle Creek would be made a tributary of Deer Creek. After mining Middle Creek would once again traverse the mined area and could be channeled so as to enter the reservoir at its premining location.

(3) An enlarged Tongue River Reservoir

Implementation of Alternate Plan A would decrease the length of spoil embankment and volume of spoil materials exposed to erosion and leaching by an enlarged Tongue River Reservoir. Impacts would be decreased accordingly.

d. Air quality

The mining of an estimated four million tons of coal per year would create impacts on air quality for the period of active mining. The major air pollutant emissions expected from this alternate mining operation are the same as those discussed in section III. A. 4. Impacts on air quality would be similar in all respects to those described in the original proposal. The magnitude of such impacts, however, would be reduced because of the smaller amount of surface disturbed (including haul roads), and the reduced tonnage of coal mined, processed, and transported.

e. Vegetation

Mining in the East Decker area under Alternate Plan A would result in the destruction of vegetation on approximately 850 to 1,000 acres, or about 60 percent less area than would be disturbed under the original proposal. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated. In the "associated disturbance" areas, the effects on vegetation would range from total destruction in some areas to relatively minor disturbances in others.

Related impacts include the loss of competitive advantage of some deep rooting plants and the loss of vegetation diversity for a period after mining. Both of these impacts are discussed under vegetation impacts for the East Decker proposal (see p. 365-366). The diversity and productivity of the vegetation that would be destroyed under Alternate Plan A would be considerably less than that eliminated under the original proposal inasmuch as spoil material would be placed in Deer Creek valley only in sec. 1, T. 9 S., R. 40 E.

The impacts on grazing and agriculture would be the same as those described for the original East Decker proposal (p. 367) because the entire project area, as under the original proposal, would be fenced.

Soil and coal dust (air-borne particulates) may influence the premining or reclaimed vegetation in the East Decker area. A discussion of dust impacts on reclaimed and native vegetation is presented on pages 367-368.

f. Wildlife

(1) Mammals and birds

(a) Mule deer

The impacts on mule deer under Alternate Plan A would be similar in most respects to those discussed for the original proposal for the East Decker area (p. 368-369). Their magnitude, however, would be somewhat reduced because of the smaller area to be disturbed. One significant impact that would be reduced under this alternative plan is the loss of habitat in Deer Creek. Less habitat would be destroyed because spoil material would be dumped into a shorter length of the valley.

(b) White-tailed deer

The amount of riparian forest area that would be disturbed under Alternate Plan A is essentially identical to that disturbed under the original proposal. A significant impact that would be less severe under this alternative is the loss of habitat in Deer Creek upstream from the riparian forest. Less habitat would be destroyed because spoil material would be dumped into a shorter length of Deer Creek valley.

(c) Antelope

Impacts on antelope in the East Decker area under Alternate Plan A would be similar in most respects to those discussed for the original proposals. Their magnitude, however, would be reduced somewhat because of the smaller acreage to be disturbed, particularly the sagebrush-steppe and grassland-sage communities. By spoiling into a shorter length of Deer Creek valley, Alternate Plan A would be less damaging to the long-term integrity of this drainage as a fawn-rearing area.

(d) Sage grouse

Of all game species in the East Decker area, the sage grouse would probably be the most impacted by mining activities. Impacts would be similar in all respects but less severe than those for the original proposal. The original mining proposal would lead to an elimination or reduction of sage grouse within the entire East Decker area. The strutting ground in sec. 7, T. 9 S., R. 41 E. should be less disturbed under Alternate Plan A than it would be under the original proposal inasmuch as "associated disturbance" and human activities would be less intensive in this area.

(e) Sharp-tailed grouse, Hungarian partridge, chukar partridge, and ring-necked pheasant

Impacts on these four species would closely approximate those described for the original proposal.

(f) Geese, ducks, osprey, and shore birds

Impacts on these species would closely approximate those described for the original proposal inasmuch as the location of the access road and railroad spur along the eastern shore of the reservoir would be unchanged. A discussion of the impacts is given on pages 371-372.

(g) Golden eagle, bald eagle, and turkey vulture

Impacts on these three large birds would closely approximate those described for the original proposal. A smaller area of potential feeding grounds would be removed under Alternate Plan A as compared to the original proposal.

(h) Nongame birds and mammals

Nongame species would be impacted under Alternate Plan A primarily by the loss of habitat. Approximately 60 percent less habitat would be destroyed under Alternate Plan A than under the original proposal for the East Decker area. A discussion of the small mammal species affected is given on page 373.

Primary consumers living in the riparian communities would be affected by this alternate mining proposal to essentially the same extent as under the original proposal.

The impacts on resident song and insectivorous birds would be less than that for the original mining proposal as less acreage would be disrupted.

(2) Fish

The fisheries of the Tongue River Reservoir could be negatively impacted if mining in the East Decker area under Alternate Plan A causes substantial changes in reservoir water quality or sediment load. Specific potential impacts to the fishery resource are discussed on page 374.

One impact that would be eliminated under this alternate plan is the damage to the important rock bass, smallmouth bass, and crappie spawning area at the outlet of the Deer Creek diversion channel under the original proposal. Alternate Plan A would not divert Deer Creek into the next bay to the north; instead, Deer Creek would be routed around the railroad spur and into the Tongue River Reservoir at its present month.

g. Archaeological and historical sites

Mining and associated activities would essentially eliminate any archaeological sites within the Alternate Plan A mining area and areas of associated disturbance. Disturbance of any of those sites identified by Fredlund (1976) in the East Decker area should have minimal impact on man's understanding of the Decker area cultural resources inasmuch as each site has been recorded and evaluated. Important artifacts have been salvaged and preserved. Conversely, mine-related disturbance of any of those sites identified by Lahren (table 33B) prior to appropriate study and recovery of artifacts could result in significant archaeological losses.[1/] Impacts to structures and ruins would be the same as those described for the original proposal.

h. Recreational facilities and activities in the Decker area

The impacts on recreational facilities would be the same as those described for the original proposal because the entire East Decker project area would be fenced and because no change in mine-related employment is anticipated.

[1/] None of the sites identified by Lahren in the East Decker area would be destroyed by mining under Alternate Plan A; however, damage from mine-related disturbances could occur to these sites.

i. Aesthetics

Mining in the East Decker area under Alternate Plan A would have approximately the same aesthetic impacts as those described for the original East Decker proposal. The magnitude of such impacts would be slightly reduced, however, as 60 percent less acreage would be disturbed by strip mining. No changes would occur, however, in the aesthetic impacts caused by the location of loading equipment, railroad spur, buildings, and coal-processing equipment.

j. Public and access roadways

As no relocation of the county road is proposed under Alternate Plan A, only those impacts attributable to increased road usage would result if this alternate is approved. The access road to the mine would be the same as under the original proposal.

k. Population, local economy, social structure, and social services

No significant changes in the impacts on population, local economy, social structure, and social services are expected if the Alternate Plan A for the East Decker mine is approved instead of the original proposal. As mine related employment (table 47, p. 463) should not vary from that predicted for the original proposal, the economic and social impacts on Sheridan should be essentially the same.

l. Land use

The area to be fenced by the proposed East Decker mine totals approximately 3,715 acres regardless of the mining plan chosen. The impacts on grazing for Alternate Plan A therefore would be the same as those described for the original proposal (see p. 367).

Impacts on land use in the Sheridan area are expected to be the same for Alternate Plan A as for the original plan because the projected population increase for Sheridan would remain essentially the same under both proposals.

5. Mitigating or compensating measures

a. Topography

Proposed and other measures that could be used to mitigate the impacts of mining on topography in the East Decker area are the same as those described under the original proposal (p. 527). The area restored after mining would be much smaller, but the methods used would be the same.

b. Soils

Proposed and other measures that could be used to mitigate impacts from soil disturbances under Alternate Plan A are the same as those described in section IV. B. 2.

c. Water Resources

(1) Ground water

Types of mitigating measures that could be used to minimize the impacts on the ground-water system in the East Decker area as a result of mining under Alternate Plan A are similar to those described in the original proposal (p. 533-548). Because of the much smaller area to be mined, however, the extent or magnitude of the measures used could be decreased accordingly. For example, interrupted aquifers must be replaced in a much smaller area, less mine effluent and waste water must be treated, a greatly reduced length of compacted-fill would be required to effectively reduce ground-water inflow to the mine from the reservoir, and fewer existing wells would be impaired and consequently must be replaced.

(2) Surface water

As with ground water, the types of mitigating measures that could be used to minimize the impacts on surface water under Alternate Plan A are similar to those described in the original proposal (p. 548-562). Elimination of the Deer Creek and Coal Creek diversions as originally proposed and an 82 percent reduction in the area mined would greatly reduce the extent or magnitude of the mitigating measures that would be required.

Possible erosion in the relocated lower reach of Deer Creek channel could be prevented by (1) armoring the banks and bed of the relocated channel with clinker riprap (p. 553-554), (2) constructing a sinuous channel that would have essentially the same width, depth, and slope as the premining channel in this reach, and (3) increasing channel roughness with vegetation and/or rock rubble.

(3) An enlarged Tongue River Reservoir

As all impacts in the East Decker area related to construction of an enlarged reservoir would be decreased by implementation of Alternate Mining Plan A, no additional mitigations would be necessary.

d. Air quality, vegetation, and wildlife

Proposed and other measures that could be used to mitigate impacts to air quality, vegetation, and wildlife under Alternate Plan A are the same as those described in sections IV. B. 4., IV. B. 5. and IV. C. 1.

e. Population, land use, economics, social structure and social services

Proposed measures for mitigating impacts to population, land use, economics, social structure, and social services under Alternate Plan A are the same as those described in sections IV. C. 2., IV. C. 3., IV. C. 4., and IV. C. 5.

f. Archaeological and historical sites

Proposed measures suggested for mitigating impacts to archaeological and historical sites under Alternate Plan A are the same as those described in section IV. C. 6.

g. Recreational facilities and activities in the Decker area

Proposed measures suggested for mitigating impacts to recreational facilities and activities in the Decker area under Alternate Plan A are the same as those described in section IV. C. 7.

h. Aesthetics

Proposed measures suggested for mitigating impacts to aesthetics under Alternate Plan A are the same as those described in section IV. C. 8.

6. Adverse impacts that cannot be avoided if Alternate Mining Plan A is adopted

a. Depletion of natural resources

(1) Coal and superjacent minerals

Approximately 20 million tons of subbituminous, low-sulfur coal would be removed from the East Decker area under Alternate Plan A. This is about 115 million tons less coal than would be mined under the original proposal. The coal removed would represent a permanent depletion of a fossil fuel resource, which would be about 0.007 percent of the total coal resources of Montana and about 0.05 percent of the strippable coal resources (p. 622).

A comparatively small amount of clinker would be intermixed with spoils materials and thereby lost to future local use as a construction material. This loss would be insignificant, however, because of the vast amount of clinker in the surrounding area. No other mineral deposits are known to occur in the area.

(2) Water resources

(a) Ground water

Under Alternate Plan A, all aquifers within the mined interval would be removed. The combined area of aquifers removed, about 2.75 square miles (p. 674), would be about 75 percent less than under the original proposal. Existing aquifers would not be physically altered outside the mined area. Within the mined area, they would be replaced by a single aquifer that should be capable of storing and transmitting larger amounts of ground water than the removed aquifers.

Because of the much smaller area mined, the rate of water loss to the Tongue River Reservoir during the period following mining when the spoil aquifer is being saturated should be less than under the original proposal, but initially, it might be as much as 3-4 acre-feet per day. Inflow to the mine area from the reservoir should decrease progressively as the level of saturation in the spoils rises and approaches reservoir level. Discharge to the reservoir through the mined area from the recharge area to the east should resume within about five years after mining and reclamation is completed.

Leaching of the spoils materials and consequent degradation of ground water within the mined area is a long-time impact that cannot be avoided (see p. 676). Water obtained from the spoils aquifer probably would be unsuitable for domestic use and would be marginal for use by livestock and wildlife. The effect of this deterioration in water quality on the use of the Tongue River Reservoir or its water should be so small as to be unmeasurable by standard sampling and testing procedures.

(b) Surface water

Mining in the East Decker area under Alternate Plan A would result in the permanent alteration or removal of about 4.8 miles of existing stream channels, or about 66 percent fewer channels than would be disturbed under the original plan. Channels altered or removed include those in the lower reaches of Deer Creek and Middle Creek valleys and those in six comparatively small unnamed ephemeral stream valleys. The lengths of the respective valleys that would be disturbed are listed on p. 674.

It is estimated that mining under Alternate Plan A would reduce total runoff to the Tongue River Reservoir by a maximum of about 50 acre-feet annually during mining and by a maximum of about 1,500 acre-feet during the first year after mining ceases. Losses should decrease progressively over a period of about five years. Long-term losses thereafter should not exceed about 25 acre-feet annually. The total loss of water to the reservoir as a result of mining under Alternate Plan A should be less than half the total loss that would be expected under the original proposal.

Leaching of spoils in the much smaller area that would be mined under Alternate Plan A should result in less degradation of water quality in the Tongue River Reservoir than under the original proposal. In both cases, however, the consequent degradation of water quality would probably be so small as to be unmeasurable by standard sampling and testing methods.

b. Topography

Alteration of the topography in the 444 acres that would be mined under Alternate Plan A and in the adjacent area that would be disturbed in conjunction with this operation is an impact that cannot be avoided if the alternate plan is implemented. Because the surface would be lowered by removal of the coal (p. 627), the topography cannot be restored to its original configuration. The proposed topography and drainage in the East Decker area after reclamation is completed under Alternate Plan A is shown in figure 74.

c. Soils

Soils would be removed, mixed, altered, and replaced on 850 to 1,000 acres disturbed directly by mining and related activities. Some minor soil disturbances would occur in adjacent areas from offroad vehicle travel and other activities indirectly related to the proposed operations. Short-term and possibly some long-term effects of reduced productivity, permeability, infiltration capacity and depth of the disturbed soils are unavoidable. Increased soil losses from erosion and increased sediment yield to the Tongue River Reservoir would occur, but their magnitude cannot be determined from available data.

d. Air quality

The major unavoidable adverse impact to air quality will be minor amounts of coal and soil dust created by the surface disturbance in the alternate mining area. The operation of mining equipment, haulage trucks, locomotives, and other mine-related machinery would emit gaseous and particulate pollutants into the airshed. This would cause a reduction of air quality on the proposed mine sites and downwind (VTN Colorado, 1975a).

e. Vegetation

Unavoidable adverse impacts to vegetation include destruction of 800-1,000 acres of rangeland in the short-term and changes in species composition and community size and location in the long-term.

Soil or coal dust may adversely affect the unmined or reclaimed vegetation in the East Decker area.

f. Wildlife

(1) Mammals and birds

All species of wildlife utilizing areas that would be disturbed by mining activities would suffer habitat losses, at least in the short-term. Human activity associated with the mining operation would also impose some unavoidable short-term impacts. For those species such as white-tailed deer, which more readily adapt or tolerate increased human activity, impacts would be less severe. Species such as antelope and sage grouse, which have very explicit habitat requirements and do not readily tolerate increased human activity, may be severely affected for a long period of time. The degree and duration of impact would depend on the length of the mining operation and timing and success of reclamation.

(2) Fish

If potential soils erosion, sedimentation, or other water resource contamination are controlled, there would be no unavoidable adverse impacts on the fisheries in the Tongue River Reservoir under Alternate Plan A for the East Decker area.

g. Loss of forage

By fencing the proposed mine boundaries, 3,715 acres of grazing land, representing a livestock carrying capacity of approximately 500 AUM's, would be lost for at least the 5 year duration of the project's life. This displacement would slightly reduce the output of farms and ranches in Big Horn County until such time as successful reclamation is achieved. If range productivity on the reclaimed mined area is not as high as or better than that before mining, the productivity of the mined area for raising livestock would have been partially sacrificed for mineral production.

h. Economics

A principal adverse, unavoidable economic impact, as discussed in section V. H., is the disparity between the governmental revenue surpluses that would accrue to Big Horn County and the State of Montana and the governmental revenue deficits that would occur in Sheridan County and the State of Wyoming. Such inequities, because of institutional constraints, are inevitable, and there is little hope of solving them in the near future.

i. Social structure and social services

As total mine related employment (table 47) should not differ from that predicted for the original proposal, impacts on housing, quality of life, social values, and community services should be identical to those discussed in section V. I.

j. Aesthetics

During the period of mining under Alternate Plan A for the East Decker area all impacts to the aesthetic environment would be unavoidable and adverse.

The length of time that this situation persists would depend on the success of reclamation. Any residual man-made facilities remaining after mining may also unavoidably and adversely affect the aesthetic quality of the area.

E. Alternate Mining Plan B for the East Decker area

1. Background

After lengthy appraisal of the Decker Coal Co.'s proposals for mining in the East Decker area, C. C. McCall, Administrator, Reclamation Division of the Montana Department of State Lands, advised the Decker Coal Co. in a letter dated February 17, 1976 (Appendix J) that several components of the proposed mining and reclamation plan are not acceptable to the Reclamation Division. They are (1) spoiling into Deer Creek valley, (2) construction of the railroad loop on a massive fill that would block the mouth of Deer Creek valley, except for a narrow channel around the north end of the fill, and (3) plans for backfilling, regrading, contouring, and reclamation involving creek entrances onto and stream channels across the mined area.

The Department considers Deer Creek valley to be a drainage that contains special values in terms of biological productivity and to be critical in terms of ecological fragility and importance. Spoiling into this valley probably would (1) constitute a hazard to the stream and to the nearby Tongue River Reservoir and (2) adversely affect the use, enjoyment, or fundamental character of these and adjacent lands. If so, Section 9 (50-1042) of Montana statutes requires that the Department delete these areas from the strip-mining permit application before it can be approved. Also, Section 10 (50-1043) requires that all measures be taken to eliminate damages from soil erosion and water pollution and hazards dangerous to life and property.

The Department also indicated that the massive fill at the mouth of Deer Creek valley was unacceptable as proposed. Moreover, the proposed fill would reduce the existing storage capacity of the Tongue River Reservoir by about 1,000 acre-feet. This loss would adversely affect the use, enjoyment, and fundamental character of adjacent lands.

The proposed final topography, which routes streams over the highwall and through haul-road depressions (fig. 9), introduces serious questions as to the long-term stability of these channels. The Department believes that the mining and reclamation plan should be revised to satisfactorily address backfilling of the final cut and recontouring of the drainage routes across the disturbed area. Post-mining channels should be capable of carrying flows that would not cause erosion greater than that occurring in premining channels.

After several meetings with Decker Coal Co. personnel and a field inspection of the lower reach of Deer Creek valley in March 1976, the Department of State Lands reaffirmed its objections to spoiling into this valley and requested that the Decker Coal Co. modify its proposed mining plan for the East Decker area to provide for (1) maximum feasible recovery of the coal resource without spoiling into Deer Creek valley, (2) construction of the railroad loop so as to provide minimal disturbance in the Deer Creek loop area, and (3) the design of stable postmining stream channels across the reclaimed mined area.

Accordingly, a special task force of Decker Coal Co. personnel was established to generate suitable alternatives. That group tentatively submitted proposals for consideration that include redesign and relocation of the railroad loop and plant facilities and three possible alternate mining methods. Each of these alternate plans promised to rectify the deficiencies identified by the Reclamation Division in the Company's initial proposals. At the time of completion of the draft environmental impact statement, the three alternate proposals were still in the formulative stage and all were under appraisal by the Reclamation Division, Montana Department of State Lands. Accordingly, all three alternatives (Plans B-1, B-2, and B-3) were described and evaluated briefly in the draft environmental impact statement.

In the interim, prior to completion of the final statement, both the Department and the Decker Coal Co. have tentatively identified Plan B-3 as the alternate proposal that would achieve maximum recovery of the coal resource and would best meet reclamation objectives of the Department of State Lands.

On January 21, 1977, the Decker Coal Co. submitted a finalized version of Alternate Plan B-3 to the Area Mining Supervisor of the U.S. Geological Survey for evaluation of its conformance to revised Federal Regulations 30 C.F.R. 211 adopted May 17, 1975. The Area Mining Supervisor has reviewed that plan for compliance with the requirements of 30 C.F.R. 211.10(c), and he has found that it meets those requirements. Consequently, Plans B-1 and B-2 have been dropped from further consideration. Accordingly, Plans B-1 and B-2 have been deleted from the final environmental impact statement and the evaluation of Plan B-3 has been greatly expanded. The text in the final statement has been simplified by dropping all further reference to Plans B-1 and B-2 and by referring to Plan B-3 hereafter as Plan B.

2. Description of the proposals

Alternate Plan B differs from the original proposal primarily in that the disturbance to Deer Creek valley would be held to a minimum and the diversion of Deer Creek would not be necessary. No spoiling would occur into the southern half of the valley from the excavation of a northern-limb box cut. The railroad loop would be moved 200 to 300 feet eastward and would no longer encompass a massive fill that would obstruct flow through the lower valley reach. Loop disturbances would be restricted to the rail corridor, the loadout area, and the proposed settling lagoons. Flow in Deer Creek would pass unimpeded beneath the railroad loop embankment through culvert pipes.

The topography after mining would closely approximate the irregularities found in the premining terrain with no final highwall depression to disrupt the gradients of Middle and Coal Creek channels. Two lakes would be left in the reclaimed surface at the locations of the final north and south pits.

The area to be mined under Alternate Plan B would be enlarged about 17 percent (from 2,175 acres to 2,540 acres) to reflect the additional data analysis and planning that has occurred since submittal of the original proposal and the different mining method that would be used. The outline of the project area (fig. 3) would be the same as under the original proposal. Recovery of the coal resource (p. 700), would be significantly greater than under the original proposal because the mining method would enable the extraction of the Anderson, Dietz 1, and Dietz 2 coal beds in the south and southeastern parts of the mine area where the appreciable thickness of overburden would prevent the economic recovery of these seams under the other proposals.

Details of the Decker Coal Co. proposals are presented in the following sections.

a. Description of the coal

Coal beds underlying the proposed mine area are the same as those described in section I. 2. b. They are the Anderson bed, which is burned in the northern part of the mine area, and the Dietz 1 and Dietz 2 beds, which underlie the entire mine area (figs. 33 and 34). The area of these beds that would be mined is shown on figure 76.

Under Alternate Plan B a total of about 192 million tons of coal, about 8 million tons per year, would be mined in the East Decker area over a period of about 24 years. This represents an increase of about 57 million tons or about 42 percent more coal than would be mined under the original proposal. Of this amount, about 5 million tons would be obtained by mining closer to the railroad than in the original proposal, about 54 million tons would be recovered by mining those parts of the Anderson, Dietz 1, and Dietz 2 beds that could not be mined under the original proposal (compare figs. 4 and 76), and about 2 million tons would be lost in the area bordering the south side of Deer Creek valley. Relevant data for the coal beds that would be mined, together with the range of overburden and interburden thicknesses, are given in the following table:

Coal bed	Average thickness (feet)	Acreage to be mined	Recoverable tonnage	Range in thickness of overburden and interburden (feet)
Anderson	25	1,593	62.4 million	30-220
Dietz 1	18	2,540	71.7 million	4-70
Dietz 2	15	2,460	57.9 million	50-70

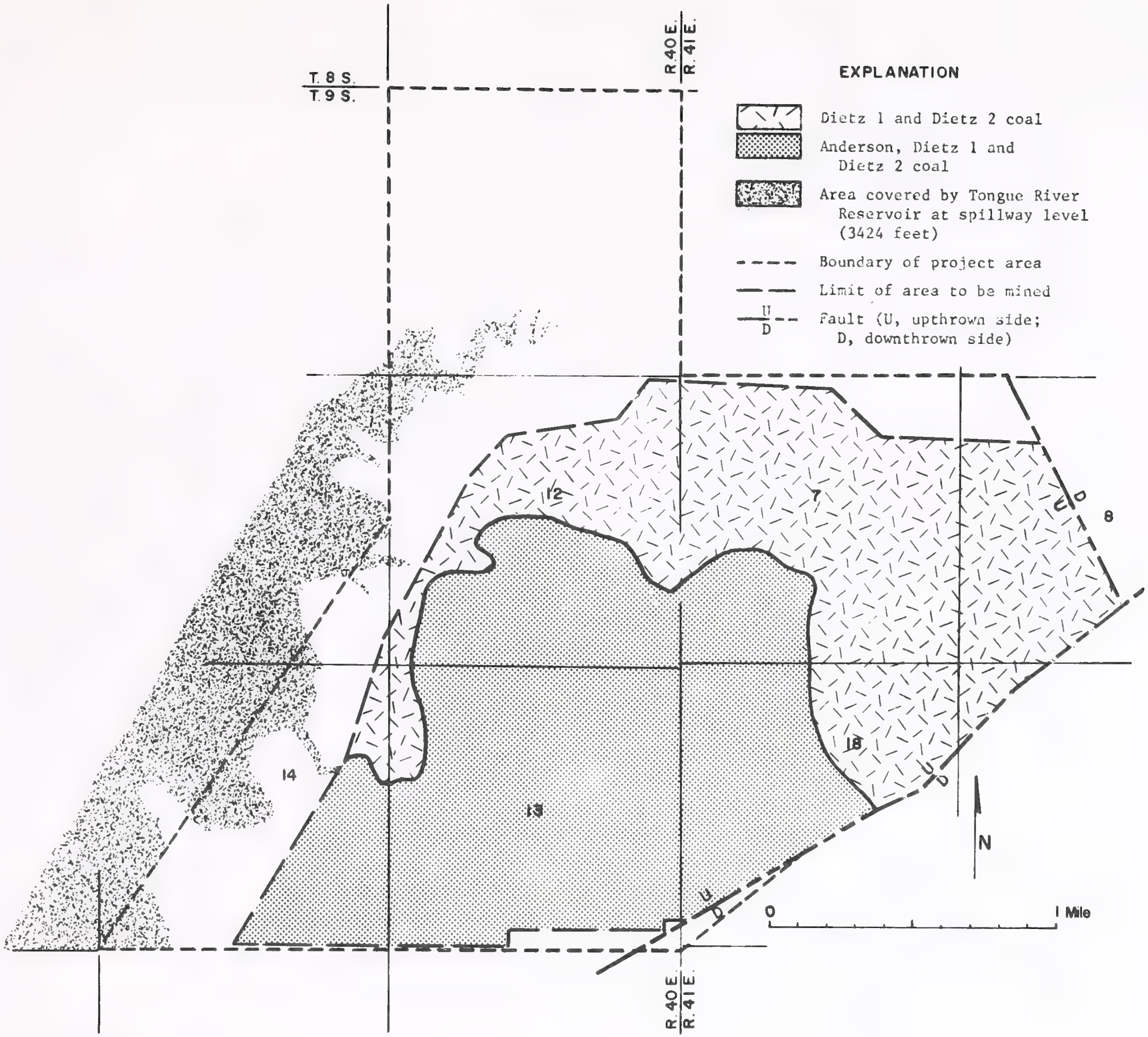

T. 8 S.
T. 9 S.
R. 40 E.
R. 41 E.
EXPLANATION
Dietz 1 and Dietz 2 coal
Anderson, Dietz 1 and Dietz 2 coal
Area covered by Tongue River Reservoir at spillway level (3424 feet)
Boundary of project area
Limit of area to be mined
Fault (U, upthrown side; D, downthrown side)
U
D
12
7
8
18
14
13
N
0
1 Mile
R. 40 E.
R. 41 E.

Figure 76.— Recoverable coal map under Alternate Mining Plan B in the East Decker area.

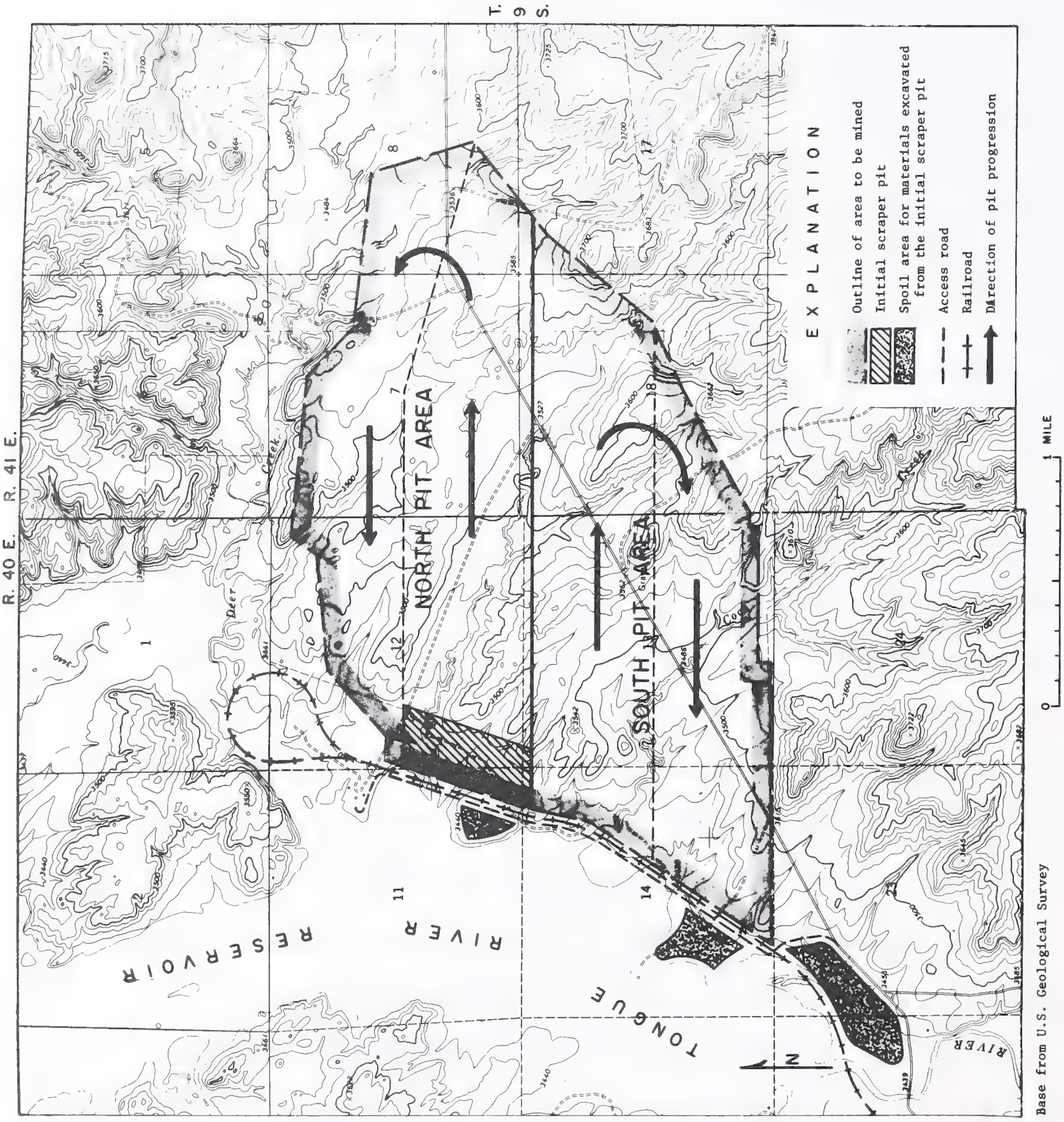
Analyses of coal samples from the Anderson, Dietz 1, and Dietz 2 beds in the East Decker area show the average heating value to be 9,350, 9,700, and 9,130 Btu/lb, respectively. The weighted average of all three beds is about 9,410 Btu/lb. Other relevant data for coal in the East Decker area are given in table B-4 (Appendix B).

b. Mining sequence

Under this plan comparatively short truck-shovel pits would be excavated instead of long dragline pits. The mine area would be divided into approximately two equal parts, a north pit area and a south pit area (fig. 77).

Using scrapers, trucks, and shovels, the initial opening cut would be made adjacent to the railroad in the southwest corner of the north pit area (fig. 77). A part of the excavated materials would be used to construct the railroad loop and shop-complex fill southwest of the railroad loop. The remainder would be placed in spoil areas in the SW¼ sec. 14, the NE¼ sec. 22, and the NW¼ sec. 23, T. 9 S., R. 40 E. (fig. 77). Topsoil from the initial box cuts would be stored in the SE¼ sec. 11, T. 9 S., R. 40 E. (fig. 77) and used for reclamation operations at the end of mining. Removal of the overburden from the initial cut and placement of the spoils elsewhere would allow mining closer to the railroad than in the original proposal and would enable recovery of about 5 million tons of coal that would not be mined under the original proposal.

The initial cut would parallel the railroad and would be about 2,500 feet long at the top of the Dietz 2 coal bed. In subsequent operations the coal would be removed from the initial cut and mining and reclamation would progress eastward using the spoils haul-back method depicted in figures 78 and 79. On reaching the fault that forms the eastern margin of the mine,



Base from U.S. Geological Survey

Figure 77. – Mining sequence under Alternate Mining Plan B in the East Decker area.

the pit would turn northward and then westward, terminating adjacent to the railroad loop. Using this method, the mined area would nowhere encroach on Deer Creek valley (fig. 77), and no spoils would be placed within the valley, except for the railroad-embankment fill previously described.

The initial opening cut of the south pit would be made adjacent to the railroad in the northwestern part of the south pit area after the north pit has progressed sufficiently eastward that one operation would not interfere with the other. Like the north pit, the south pit would be about 2,500 feet long on the top of the Dietz 2 coal bed and would progress eastward to the eastern mine boundary. There it would turn southward and then westward to terminate adjacent to the railroad.

The final cuts on both the north and south pits would be left as closed depressions to form deep lakes. These lakes and the adjacent area would be completed as recreation sites, ownership of which would be transferred from the Decker Coal Co. to the State of Montana.

c. Mining procedures

(1) Soil material removal and storage

Procedures for handling soil materials would be the same as those described in section I. A. 2. d. (1). Topsoil removed from areas disturbed during the construction of the railroad, plant site, building site, access road, and initial pit would be stockpiled. Thereafter, topsoil removed in advance of mining would be transported and replaced on recontoured spoils in one operation, avoiding insofar as possible the need to stockpile.

(2) Overburden, interburden, and coal removal

After removal of the topsoil, overburden and interburden would be drilled and blasted using the same procedures as those described in section

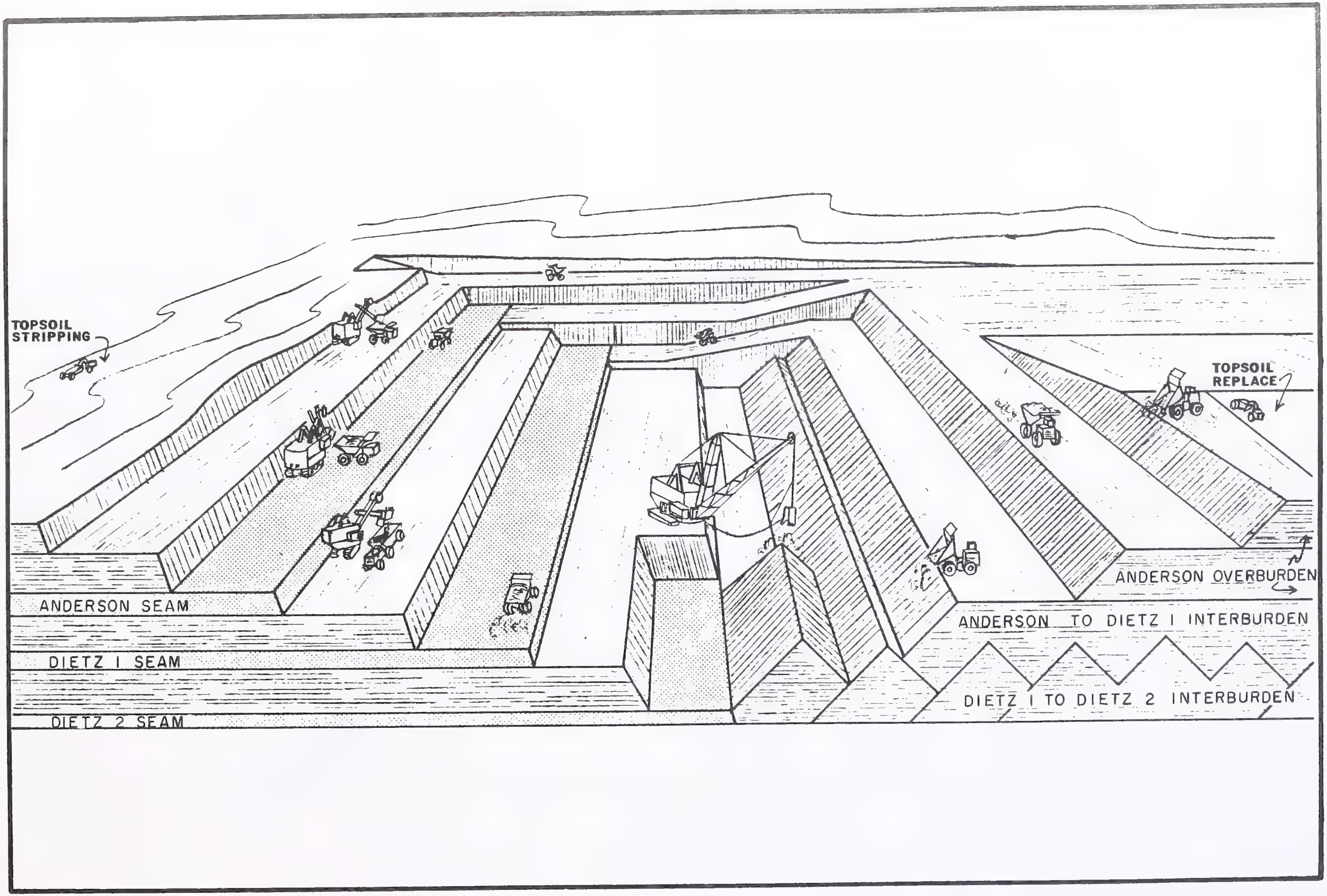


Figure 78.--Schematic block diagram showing method of overburden and coal removal and placement of spoils under Alternate Mining Plan B in the East Decker area.

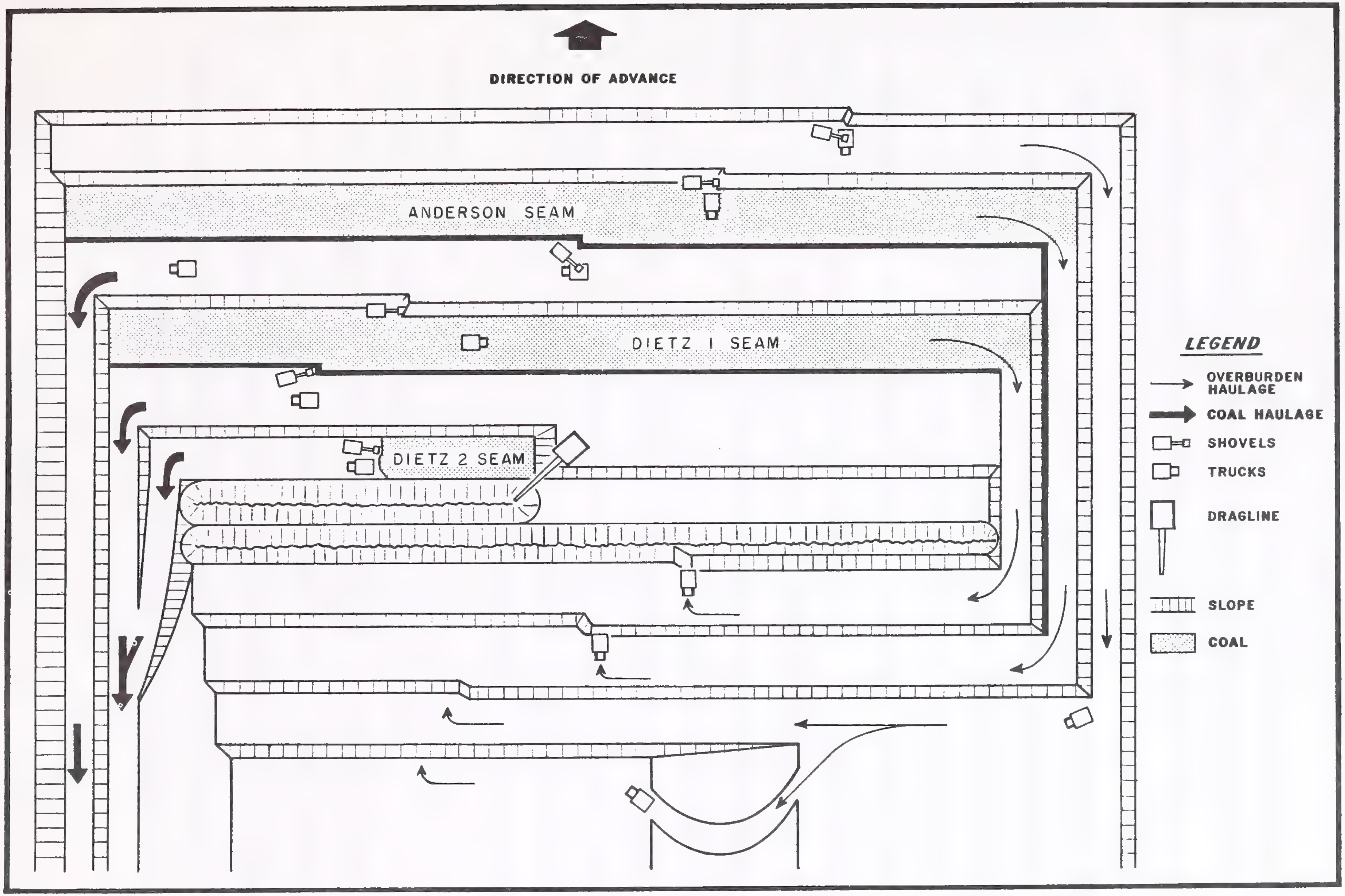


Figure 79.--Schematic diagram showing plan view of method of overburden and coal removal and placement of spoils under Alternate Mining Plan B in the East Decker area.

I. A. 2. d. (2). On the average about one blast per day consisting of about 50 holes would be required.

The broken overburden overlying the Anderson seam would be removed by a truck-shovel fleet consisting of 170-ton-capacity end-dump trucks and 25-cubic-yard shovels. This fleet would excavate and work on one or more benches, depending on the thickness of the overburden (figs. 78 and 79). Individual benches would be sufficiently wide to assure safe operating conditions and normally would be separated from the next higher or lower bench by a vertical distance of not more than 50 feet.

Once exposed, the Anderson coal bed would be drilled and blasted as described in section I. A. 2. d. (3). On the average about 2 blasts per day of 20 holes each would be required. The coal would be loaded into 150-ton bottom-dump trucks with one 16- and one 30-cubic-yard shovel and hauled to the coal loadout area.

After extraction of the Anderson coal bed, the interburden between the Anderson and Dietz 1 beds would be drilled and blasted, and the broken rock would be removed by the truck-shovel fleet. The Dietz 1 seam, in turn, would be drilled, blasted, and removed as described above.

The interburden between the Dietz 1 and Dietz 2 coal beds then would be drilled and blasted, and the broken rock would be excavated with a 40-cubic-yard dragline and deposited in the bottom of the adjacent mined out area of the pit (fig. 78). The Dietz 2 coal seam, in turn, would be drilled, blasted, and removed as described for the Anderson bed.

Blending of the coal from the separate seams to meet customer specifications requires that the three coal beds be mined simultaneously.

Accordingly, the overall mining operation, would involved the simultaneous coordination of all the individual steps described above, each acting in concert with the others so as to move the active pit progressively forward, leaving behind a mined-out area ready for reclamation operations.

In the mining procedure, the removal of the overburden and interburden would be completely segregated from the coal loading and hauling operations. Trucks moving spoil materials would run on the top of coal beds or on benches cut in the overburden; trucks moving coal would run on the bottom of coal beds (fig. 78). Facing in the direction of pit advance, spoil materials would be hauled around the right side of the active pit and dumped on the irregular surface of the dragline-laid spoils; coal would be hauled around the left side of the pit to the coal loadout area (fig. 79). Coal haul roads for both the north and south pits would be left open and not filled with spoil materials as the pits advance eastward. These same roads would then be used when the pits turn around at the last margin of the mine area and advance back westward. All haul-road depressions would be filled as necessary and the surface reclaimed following the westward advance of the pits. Final depressions would be left at the western terminus of both the north and south pits.

(3) Production rate

Under Alternate Plan B, the East Decker mine is scheduled to produce 4-5 million tons of coal in 1978, about 6 million tons in 1979, and about 8 million tons annually thereafter until 1997. Annual production would be decreased to about 4 million tons in 1997 and would continue at that reduced rate until the reserve is depleted.

(4) Reclamation

All reclamation operations would comply with applicable State and Federal rules and regulations pertaining to the surface mining of coal and related activities. Backfilling, grading, and final reclamation would proceed as close to the coal-loading operation as the most advanced state of the art would allow, but no further than two spoil banks behind the active mining area.

(a) Spoil reclamation

Overburden and interburden materials obtained from excavation of the initial north and south pits would be hauled to the spoil areas shown in figure 77. These spoil areas would be leveled, topsoiled, and reseeded at the first seasonal opportunity. Thereafter, all spoil materials would be used in the backfilling operation, which would follow immediately behind the removal of the lowest (Dietz 2) coal bed (fig. 78). These spoils would be replaced in approximately the same relative position that they occupied prior to mining. The interburden between the Dietz 1 and Dietz 2 beds would be placed in the bottom of the pit by the dragline. These materials in turn would be covered by the interburden from between the Anderson and Dietz 1 beds and by the overburden above the Anderson bed (fig. 78).

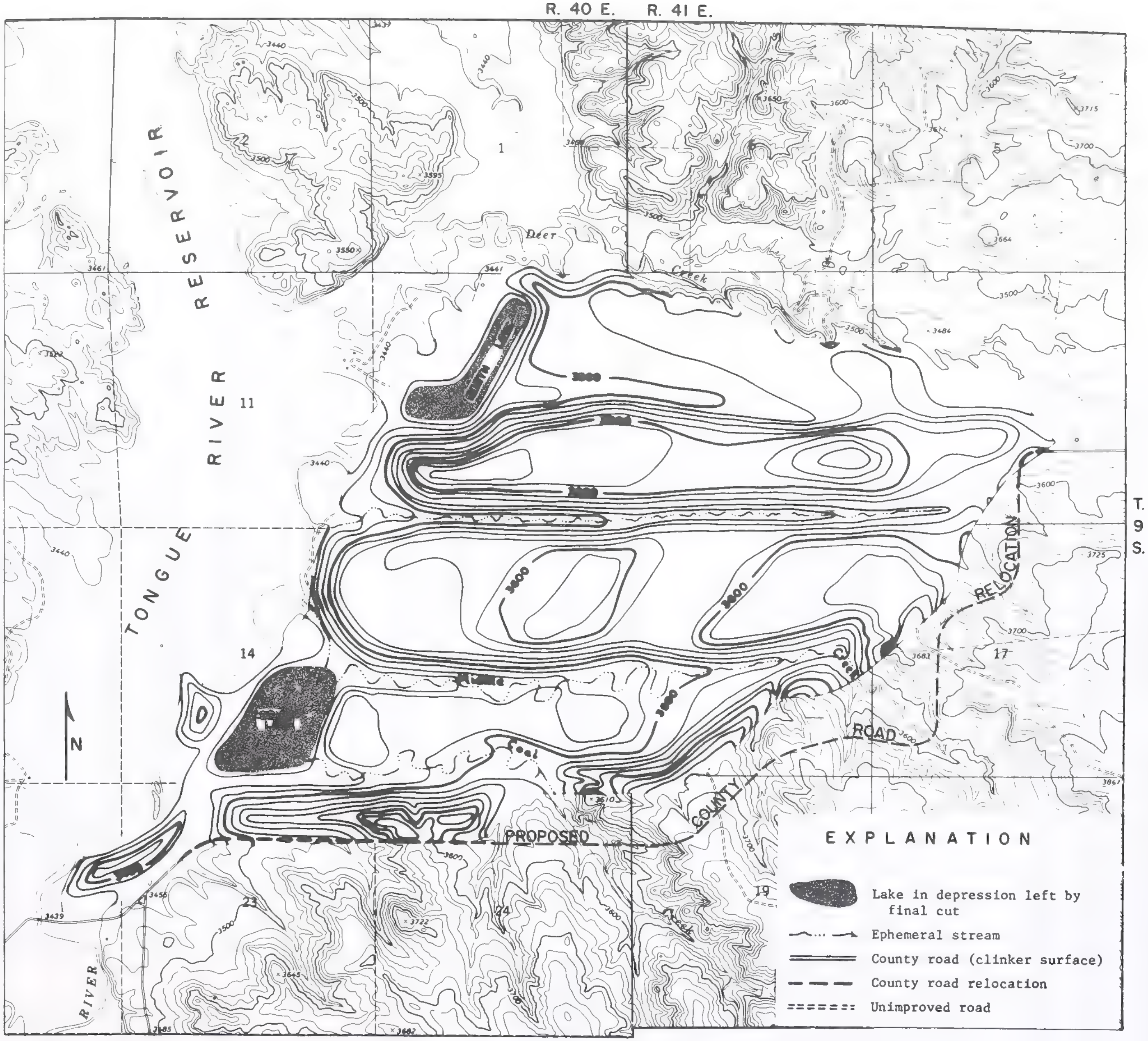
The spoils surface would be smoothed with a dozer and road grader to approximately restore the original contour that existed prior to mining. The final highwall would be reduced to a slope no steeper than 20° (36 percent). All other slopes would be reduced to a 5 to 1 (20 percent) or less grade. The proposed final topography for the reclaimed mine area under Alternate Plan B is shown in figure 80.

The dominant features of the final surface would be two deep depressions left by the final north and south pits (fig. 80). It is assumed that surface runoff and ground-water inflow to these depressions would form lakes that would overflow to the Tongue River Reservoir at a water surface elevation of about 3,425 feet. Relevant data for these inferred lakes at an elevation of 3,425 feet are summarized in the following table.

	North Lake	South Lake
Surface area	50 acres	110 acres
Average depth	75-100 feet	100-125 feet
Maximum depth	130 feet	230 feet
Area of surface drainage	570 acres	5,700 acres

Both Middle and Coal Creeks would be diverted into the South Lake. A comparatively small part of the reclaimed mine area would be tributary to the North Lake. The central part of the mine area would drain eastward to the Tongue River Reservoir through a depression left in the surface along a reclaimed coal haul road (fig. 80). The regraded topography would reestablish stream channels at premining gradients and provide an irregular rolling terrain that would approximately restore the original contour. Any spoil material not conducive to revegetation would be buried more than 8 feet below the surface of the regraded spoil.

After final grading is completed, the affected area would be scarified to increase the permeability of the spoil materials and to minimize slippage between the spoil and the topsoil layer.



Base from U.S. Geological Survey

Figure 80.— Proposed topography and drainage after mining under Alternate Plan B in the East Decker area.

(b) Topsoiling

Topsoil would be placed on the recontoured scarified spoil materials in one application using push-pull scrapers. This layer of topsoil, which would average 18-24 inches in depth, then would be scarified and disced to increase permeability and prepare for seeding. Fertilizer (18-46-0) would be applied using 200 pounds per acre, and a Kongskilde "Tripple-K" harrow would be used to integrate the fertilizer into the soil layer.

(c) Seeding

Seeding would be done on the contour at the rate of 25 pounds of pure live seed per acre using a 12-foot Brillion grass seeder or a John Deere grain drill equipped with a gauge-o-matic depth control. The objective would be to establish a permanent, diverse cover of predominantly native species. The following seed mixture is proposed:

Species	Pounds/acre (pure live seed)
Western wheatgrass	6
Thickspike wheatgrass	6
Slender wheatgrass	3
Whitmar wheatgrass	1
Green needle-grass	4
Prairie sandreed	1
Blue grama grass	1
Pubescent wheatgrass	1
Smooth brome grass	1
Sainfoin	.5
Fourwing saltbush	Trace to 1
Total	25 lbs/acre

In addition, small amounts of big sagebrush, skunkbrush sumac, little bluestem, side oats grama, ponderosa pine, Rocky Mountain juniper, and western chokeberry would be planted on suitable sites. Such species would increase the postmining ecosystem diversity and stability. Tree species would be planted by hand using young plants in those areas where species-specific habitat and microclimatic conditions are suitable.

Retopsoiled areas would be seeded before April 15 and/or after October 15 when chances for successful seedling establishment are greatest. In conjunction with seeding, all topsoiled areas would be fertilized according to need as established by soil analysis. Mulching and sprinkler irrigation would be used as necessary.

Replanted areas would be fenced as needed to prevent further disturbances and would be monitored continuously by qualified reclamation specialists employed by the company.

(d) Estimated cost

The estimated cost per acre of the individual operations included in reclamation are given in the following table:

1. Backfilling and grading	$ 666.00
2. Topsoil replacement	3,541.00
3. Seeding and/or planting	469.00
4. Fertilizer	43.00
5. Maintenance	50.00
TOTAL COST PER ACRE	$4,769.00

(5) Water diversion and impoundment

The proposals under Alternate Plan B differ significantly from the original proposals in that large impoundments would be constructed to intercept peak discharges from watersheds interrupted by the mining operations rather than to divert those high flows directly through diversion channels constructed around the mine area. Adequate storage capacity within the impoundments would be maintained by pumping excess runoff into comparatively small diversion channels constructed around the mine area.

(a) Design of structures

All water-control structures would be designed and constructed in accordance with established engineering standards and practices and in conformance with all applicable Federal and State laws and regulations to insure stability and an adequate margin of safety over the life of the proposed operations.

Impoundment structures would have a safety factor of 1.5 or greater using the slip-circle method as suggested in the U.S. Bureau of Reclamation handbook "Design of Small Dams." All impoundments having a capacity in excess of 20 acre-feet would be designed to hold all runoff from a calculated 50-year storm of 24-hour duration and would meet standards established by Federal Regulations 30 C.F.R. 77.216(a). Dams would be 22.5 feet wide at the top. The upstream face would slope 3:1 and would have a clinker riprap surface where necessary. The downstream face would slope 2:1 and would be grassed. Cutoff trenches would be used where necessary to prevent excessive seepage and structural instability. Emergency spillways would be constructed to prevent failure of structures in the event of excessive runoff in response to a storm having a recurrence interval greater than 50 years.

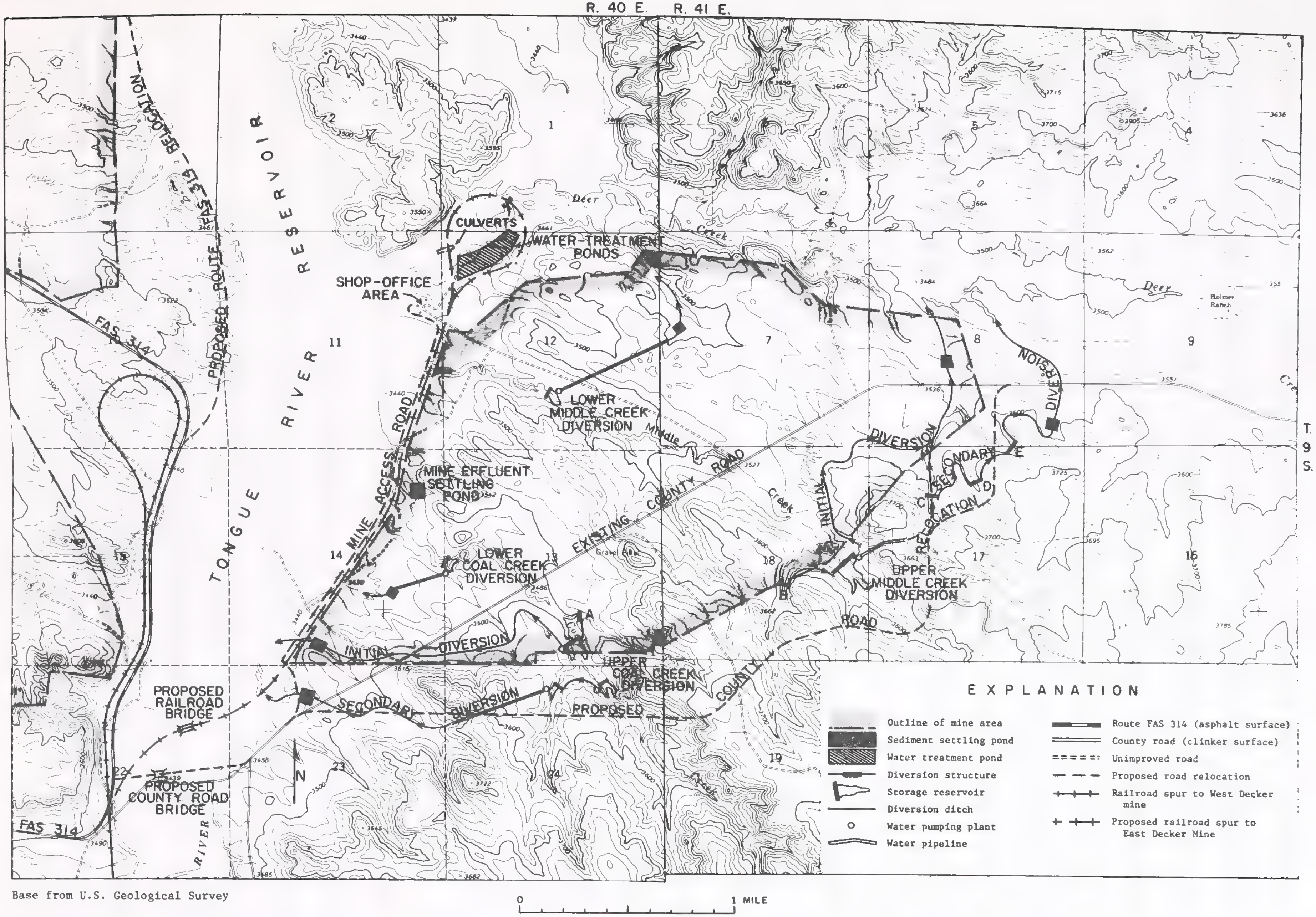
Settling ponds would be designed and constructed the same as other water-impoundment structures.

Diversion channels would be designed and constructed to carry the maximum estimated discharge pumped from the water impoundments plus any additional runoff that might enter the channels directly from adjacent uncontrolled areas. Channels would be trapezoidal in cross section with sides sloping 2:1. Channel banks would be 15 feet wide at the top and leveled to provide vehicle access for inspection and maintenance. Ditch bottoms, side slopes, and adjacent roadways would be surfaced with clinker wherever necessary to prevent erosion.

(b) Middle Creek diversion system

The system used to divert water from the Middle Creek watershed around the proposed mine area would have several component parts and would be modified in several stages as mining progresses. Initially, two impoundments would be constructed in the Middle Creek drainage near the southeastern margin of the mine area (fig. 81). The Upper Middle Creek Diversion would be built on the main stem of Middle Creek and would have a capacity of about 215 acre-feet, which is about 20 percent (35 acre-feet) greater than the calculated runoff from a 50-year storm of 24-hour duration. The added capacity would provide for sediment storage and accommodate minor runoff over the life of the project. Impoundment B would be located about 0.3 mile to the west on a comparatively small tributary of Middle Creek. This impoundment would have a flood-storage capacity of about 15 acre-feet and would divert essentially all runoff into a ditch that would drain generally eastward into the main Middle Creek impoundment (fig. 81).

Water and sediment impounded in the Upper Middle Creek Diversion structure would be allowed to accumulate to a maximum volume of about 35 acre-feet, thereby always maintaining adequate storage to contain all



Base from U.S. Geological Survey

Figure 81. — Proposed water-diversion system, access road, county road relocations, and railroad spur for Alternate Mining Plan B in the East Decker area.

runoff from a 50-year storm of 24-hour duration. Runoff in access of the 35 acre-feet of dead storage would be pumped from the impoundment at a rate that would reduce the stored volume to 35-acre feet or less in a period of no more than 10 days. Maximum pumped discharge would be about 10 ft^3/s. Initially, this outflow would be pumped into a diversion channel that would carry the runoff generally northeastward, approximately following the contour into the next drainage to the east (fig. 81). The water would pass through a settling pond having a capacity of 6-10 acre-feet that would provide a minimum detention period of 8 hours. Outflow from the settling pond would be through an existing channel to Deer Creek.

After about four years, the active pit would encroach upon this diversion channel, requiring the construction of a pipeline from the reservoir over the ridge to the east (fig. 81). Water pumped through this pipeline would be discharged at the same rate of about 10 ft^3/s into the same drainage net as before, only further upstream. Discharge from the pipeline, therefore, would pass downstream through the existing settling pond before entering the Deer Creek channel. Because the initial diversion channel would be used only about four years, the possibility exists that the pipeline might be installed at the outset of the mining operations, thereby eliminating the need for the diversion channel.

About midway in the mining operation, the active pit would intercept the drainage carrying the pumped outflow from the Middle Creek impoundments. At that time it would be necessary to construct a series of small diversion structures (dams C, D, and E, fig. 81) and a connecting diversion channel to carry the pumped outflow from Middle Creek generally northeastward around the mine area. These impoundments and the secondary diversion channel also would intercept and carry runoff from the small watersheds upslope. A new settling pond of approximately the same capacity as the one replaced would be constructed near the downstream end of the secondary diversion channel (fig. 81).

Following the completion of mining and reconstruction of Middle Creek channel across the reclaimed mined area, all remaining impoundments, pipelines, and diversion channels would be removed and the surface areas restored.

Runoff from within the mine area downstream from the Upper Middle Creek Diversion system initially would be impounded by constructing a Lower Middle Creek Diversion structure across Middle Creek channel immediately east of the active permit area (fig. 81). The reservoir thus formed would have a capacity of only about 20 acre-feet and would not be designed to contain the calculated runoff from a 50-year storm of about 50 acre-feet. Runoff in excess of the reservoir capacity would overflow through an emergency spillway and enter the active pit where it would be treated as mine effluent. Water impounded in this structure would be pumped through a pipeline northeastward and discharged through a settling pond into an ephemeral stream that is tributary to Deer Creek. Maximum pumped discharge would be about 1.0 ft^3/s, which would empty the impoundment in a period of not more than 10 days. Capacity of the settling pond would be about 2 acre-feet. As mining progresses eastward and encroaches on this structure, it would be replaced by successive impoundments and pumping stations built further upstream. Because of the progressively decreasing size of the contributing area, each impoundment would be smaller than its predecessor, but all would be adequate to contain the calculated mean annual flood. All pumped discharge from these temporary impoundments would be routed through settling ponds that would provide a minimum detention period of 8 hours.

(c) Coal Creek diversion system

The diversion system used to control runoff from the Coal Creek watershed would be generally similar in operation to the system described above for Middle Creek. Initially, two structures would be constructed, one on the main channel of Coal Creek and one (dam A) about 0.1 mile northeast on a small tributary drainage (fig. 81). Both structures would be inside the proposed mine area. Dam A would divert all runoff from the tributary drainage through a diversion channel into the larger impoundment, which would have a capacity of about 60 acre-feet. This capacity is about 20 percent (10 acre-feet) greater than the calculated runoff from a 50-year storm of 24-hour duration. Water and sediment impounded in the structure would be allowed to accumulate to a maximum volume of about 10 acre-feet, thereby always maintaining adequate storage to contain all runoff from a 50-year storm of 24-hour duration. Runoff in excess of the 10 acre-feet of dead storage would be pumped from the impoundment of a rate that would reduce the stored volume to 10 acre-feet or less in a period of no more than 10 days. Maximum pumped discharge would be about 2.5 ft^3/s. Water pumped from this impoundment would be discharged into an initial diversion channel that would carry the flow generally westward approximately following the contour to a settling pond constructed in the southwestern corner of the mine area (fig. 81). Outflow from this settling pond, which would have a capacity of about 2 acre-feet and would provide a minimum detention period of 8 hours, would be discharged through an existing ephemeral stream channel to the Tongue River Reservoir.

Runoff from within the mine area downstream from the Upper Coal Creek Diversion system would be impounded by a Lower Coal Creek diversion structure that would function similar to the lower structure described on Middle Creek. This impoundment also would have an initial capacity of about 20 acre-feet. Runoff in excess of the reservoir capacity would spill into the active pit where it would be treated as mine effluent. Water entering the reservoir would be pumped through a pipeline southwestward into a settling pond in the southwestern corner of the mine area (fig. 81). Maximum pumped discharge would be about 1.0 ft^3/s; capacity of the settling pond would be about one acre-foot. As mining progresses eastward and encroaches on this structure, it would be replaced by successive impoundments and pumping stations built further upstream. The overall design and operation of this water-control system on lower Coal Creek would be the same as that on Middle Creek within the mine area.

In about 1990-91 the mining operation would require removal of the initial Upper Coal Creek structures. Prior to their removal, two impoundments would be constructed outside the mine area about a quarter of a mile upstream, one on the main channel of Coal Creek and the other on a tributary that enters from the west (fig. 81). The impoundment on the main channel would have a capacity of about 45 acre-feet (37 acre-feet flood storage and 8 acre-feet dead storage for sediment and low flows). The impoundment on the tributary channel would have a capacity of about 33 acre-feet (27 acre-feet flood storage and 6 acre-feet dead storage). Runoff into the impoundment on the main channel in excess of the dead storage of 8 acre-feet would be pumped into a channel that would carry the flow westward into the impoundment on the tributary stream (fig. 81). Maximum pumped discharge to reduce the stored volume to 8 acre-feet or less in 10 days would be about 1.9 ft^3/s. Concurrently, water would be pumped from the tributary impoundment into a pipeline that would carry the flow southwestward and discharge into a natural drainageway that is tributary to the Tongue River Reservoir (fig. 81). Maximum pumped discharge would be about 3.2 ft^3/s. This flow through the Coal Creek secondary diversion system would be routed through a settling pond having a capacity of about 3 acre-feet that would provide a minimum detention period of 8 hours.

Following the completion of mining and reconstruction of Coal Creek channel across the reclaimed mine area, all remaining impoundments, pipelines, and diversion channels would be removed and the surface areas restored.

(6) Employment requirements

Employment requirements under Alternate Plan B would not differ greatly from those under the original proposal. A nonpermanent construction force of about 300 is projected for the first year, and about 200-225 is projected for the second year, after which construction-related employment would end. Production would begin during the second or third years with a permanent work force of about 200 people, expanding to about 303 people over the next three years.

Estimated employment for full coal production of about 8 million tons per year is given in the following table:

Shifts/day	Days/week	Type	Total
3	5	Scraper operator	6
3	5	Overburden drill operator	12
1	5	Overburden powderman	6
3	5	Dragline operator	3
3	5	Dragline oiler	3
3	5	Truck dozer operator	6
1	5	Coal drill operator	1
1	5	Coal powderman	2
2	5	Truck drivers	52
2	5	(overburden and coal)	14
		Shovel operators	
2	5	Shovel oilers	14
3	7	Mechanical-maintenance	88
1	5	Laborers	8
3	5	Pumpmen	3
3	5	Warehouse	4
2	5	Rubber-tired dozer operator	10
3	5	Patrol operator	12
3	7	Plant operator	4
3	7	Plant oiler	4
3	7	Plant labor	4
3	7	Plant maintenance	4
2	5	Water truck operator	4
		TOTAL estimated craft employees	264

In addition, about 39 overhead and supervisory personnel would be employed. The total work force, therefore, would number about 303 people.

d. Mining facilities and equipment

Requirements under Alternate Plan B would be generally similar to those under the original proposal with the exception that movement of the overburden would be effected largely by a truck-shovel fleet instead of by draglines.

(1) Roads

(a) County road relocation

Relocation of the county road would require construction of about 4.35 miles of new roadway south of the mine area. This new road would connect with the existing county road near the southwestern and the eastern margins of the mine area (fig. 81) and would function thereafter as the permanent relocated county roadway. Construction would be completed in one stage, instead of in two stages as described in the original proposal. The design and construction methods would meet all applicable county standards. All costs of this road relocation would be borne by the Decker Coal Co.

(b) Access road

Because of relocation of the plant area under Alternate Plan B, the access road to the East Decker mine would be shortened from about 3.6 miles under the original proposal to about 2.2 miles under Plan B (compare figs. 10 and 81). The design and construction of the concrete bridge over the Tongue River and the access road to the mine, except for its shorter length, would be the same as under the original proposal. All costs of road design, construction and aquisition of right-of-way would be borne by the Decker Coal Co.

(c) Haul roads

Two types of haul roads would be constructed, those used to truck overburden from in front of the active pit to behind the pit, and those used to truck the coal to the loadout area (fig. 79). Road widths would depend on the intended traffic patterns. Roads carrying two-way traffic would be about 95 feet wide and would have a central berm to separate traffic lanes. One-way roads would be about 50 feet wide and would have no center berm.

Overburden haul roads would be removed and reclaimed as the pit advances. Coal haul roads would be left open and used continuously as mining operations proceed eastward. Once the pits turn westward, however, the unused portions of these coal haul roads would be backfilled and the area topsoiled and revegetated at the first seasonal opportunity.

All haul roads would be constructed and maintained in keeping with the following standards:

1. Roadways would be surfaced with crushed clinker obtained from the mine area. No refuse coal, acid producing or toxic materials, or other materials that might increase concentrations of suspended solids in surface drainages would be used.
2. No sustained grade would exceed 8 percent.
3. The maximum pitch grade would not exceed 12 percent for a distance of more than 300 feet.
4. Maximum pitch grade would not exceed 300 feet in length for each 1,000 feet of roadway.
5. The grade on switchback curves would be reduced to less than the approach grade and would not be greater than 10 percent.
6. Cut slopes would not exceed 2:1 in unconsolidated materials or 1:1 in bedrock.
7. Drainage ditches would be constructed on both sides of cut sections and on the inside shoulder of cut-fill sections. Ditch relief cross drains would be spaced according to grade. Water would be intercepted before reaching a switchback or large fill and would be drained off or released below the fill.
8. All cut and fill slopes would be stabilized and revegetated at the first seasonal opportunity.

(2) Railroad

The railroad loop would be moved 200-300 feet eastward so as to intercept as few meanders of the Deer Creek channel as possible. An earthern-fill embankment would be used in Deer Creek valley to minimize disturbances in the central part of the loop, and two culverts (fig. 81) would be installed to carry runoff in Deer Creek beneath this embankment. Both culverts would be of sufficient size to pass the peak discharge during a 50-year flood event.

With those exceptions, design and construction of the railroad spur to the East Decker mine and the railroad bridge over the Tongue River would be essentially the same as under the original proposal (see section I. A. 2. e. (2)).

At design production capacity of about 8 million tons per year, approximately 15-16 unit trains would be loaded and transported across the spur line each week.

As under the original proposal, a short length of track on the east side of the loop would be used to unload ammonium nitrate for use in blasting. A A track on the west side of the loop (fig. 82) would be used to deliver materials to the shop area and the equipment erection site.

(3) Power

Distribution of electric power under Plan B would be essentially the same as under the original proposal (section I. A. 2. e. (3)). Power consumption is estimated to be about 25 million kwh per year.

(4) Structures

Major structures constructed at the mine under Plan B would be essentially the same as under the original proposal (compare figs. 11 and 82). The location of the plant area, however, would be immediately southwest of the

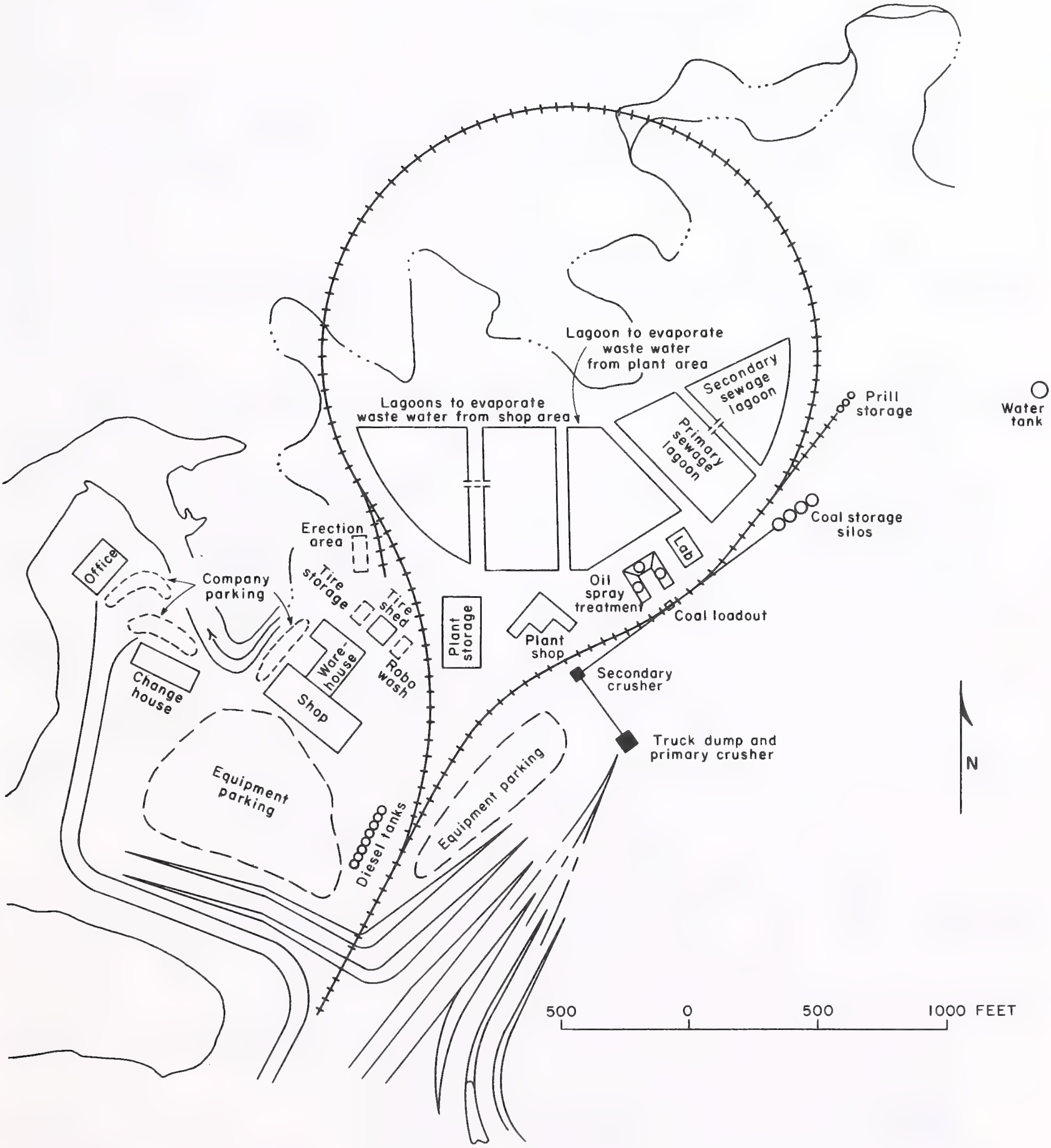


Figure 82.- Proposed plant area for the East Decker mine under Alternate Plan B.

railroad loop instead of on a massive fill in Deer Creek valley northeast of the loop.

(5) Fuel and explosives storage

Storage of fuels and explosives would be essentially the same as under the original proposal with the exception that the location of storage facilities would be changed (compare figs. 11 and 82) and, based on experience gained at the existing West Decker mine, one additional prill silo would be constructed. All facilities for the storage of explosives would meet standards established by 26 C.F.R. 181.

Annual consumption of fuels and explosives are estimated as follows:

Type		Annual consumption
Diesel fuel	-	4,100,000 gallons
Gasoline	-	150,000 gallons
Ammonium nitrate prills	-	12,000,000 pounds

(6) Coal processing and storage facilities

These facilities would be the same as under the original proposal (section I. A. 2. e. (6)).

(7) Water supplies and waste disposal

Total water consumption at the plant area under Alternate Plan B is estimated to be about 103,000 gallons per day (0.32 acre-ft/day). Use and disposal of the water would be as follows:

Use	Quantity (gal/day)	Disposal following use
Domestic	11,000	Evaporated from sewage lagoons
Dust control during handling and loading coal	84,000	Would leave mine area in unit trains with the coal

Equipment wash, plant wash down, shop wash down and rinse	8,000	Evaporated from waste-water lagoons
Fire control	No daily use anticipated	Any runoff would enter waste-water lagoons.

Water for the plant area would be obtained from one or more shallow wells drilled nearby that would have a combined sustained yield of about 100 gal/min.

Water from the reservoir or from these wells would be stored in a 300,000 gallon tank located just east of the railroad loop (fig. 82).

In addition to water consumption in the plant area, about 360,000 gal/day (5 days per week) would be obtained from mine effluent and used for dust control, primarily on haul roads. Application rates would be such that no runoff and consequent erosion would occur.

All waste water and runoff from the plant and shop areas, which would cover about 29 acres each, would be contained in and evaporated from clay-lined lagoons located inside the railroad loop (fig. 82). Clay for lining these lagoons would be obtained from commercial sources at Kaycee, Wyoming. All lagoons would be constructed so as to prevent, insofar as possible, discharge into surface or subsurface waters. The tops of the dikes forming the lagoons would stand at an altitude of about 3,440 feet, which is about 16 feet higher than spillway level of the Tongue River Reservoir.

The lagoons would have the following surface areas and capacities:

			Capacity		
Type of lagoon	Number	Surface area (acres)	Active storage (acre-ft)	Sediment storage (acre-ft)	Total storage (acre-ft)
Primary sewage	1	1.5	5.3	1.2	6.5
Secondary sewage	1	2.1	7.8	1.8	9.6
Waste water	3	8.6[1]	40.0[1]	11.1[1]	51.1[1]

[1] Data are for combined surface areas and capacities.

The estimated volume of sewage would be about 12.3 acre-feet (4 million gallons) annually and the estimated volume of waste water and runoff would be about 36.8 acre-feet (12 million gallons) annually. If the surface areas of the sewage or waste-water lagoons are not adequate to evaporate all inflow, any excess water would be treated as necessary and used for dust control on haul roads or dust control during coal-processing operations.

(8) Mining equipment

A list of the major equipment that would be used in the mining operation is given below. In addition, miscellaneous support equipment such as pickups, cranes, mechanic trucks, fuel and lubrication trucks, and shop equipment would be used.

Number	Size[1/]	Description
1	40-cubic-yard	Dragline
5	25-cubic-yard	Overburden shovel
1	16-cubic-yard	Coal shovel
1	30-cubic-yard	Coal shovel
23	170-ton	End-dump truck
7	150-ton	Bottom-dump truck
2	834 Caterpillar	Rubber-tired dozer
7	D9 Caterpillar	Dozer with ripper
3	#16 Caterpillar	Patrol
4	637 Caterpillar	Scraper
3	10,000-gal	Water truck
2	3-ton	Anfo truck
1	12-ton	Anfo truck
1	60R Bucyrus Erie (12")	Drill
1	45R Bucyrus Erie (9")	Drill
1	RDC-16 Gardner Denver	Drill
3	7-ton	Flatbed
2	1½-ton	Flatbed

[1/] Trade names are used to indicate size of equipment only and do not denote equipment purchased.

(9) Reclamation equipment

A list of major reclamation equipment that would be used in reclamation operations is given below:

Number	Size[1]	Description
1	7040 Allis-Chalmer 3500 Mark II	Tractor
1	SST-120 Brillion	Grass seeder
1	8300 John Deere	Grain seeder
1	SGB-4127 Tripple K	Harrow
1	John Deere	Mower
1	3-disc	Plow
1	126" offset harrow and 26" discs with scrapers	Harrow
1	D9 Caterpillar	Dozer
4	637 Caterpillar	Scraper
1	#16 Caterpillar	Patrol
3	--	Light plants

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[1] Trade names are used to indicate size of equipment only and do not denote equipment purchased.

3. Description of the environment

The existing environment in the East Decker area, including the additional area that would be disturbed under Alternate Plan B, is described in section II.

4. Environmental impacts of the proposals

Adoption of Alternate Mining Plan B would result in the mining of about 17 percent more area than would be mined under the original proposal.

Accordingly, the environmental impacts generally would be greater than under the original proposal, but not necessarily proportionately so. The outline of the project area (fig. 3) under Plan B would be the same as under the original proposal.

a. Topography

The proposed reclaimed surface would differ significantly from that in the original proposal (compare figs. 9 and 80). By using the truck-shovel fleet and haul-back method of Plan B instead of draglines to move the bulk of the spoil materials, considerable flexibility would be obtained in resculpturing the final surface.

In broad aspect, the reclaimed surface would consist of a series of elongate, west-trending rounded ridges separated by intervening parallel depressions or valleys that would provide surface drainage westward toward the Tongue River Reservoir. The valleys would be aligned along reclaimed coal haul roads. No final high wall would be left along the south and east margins of the mined area to disrupt channel profiles. Middle Creek and Coal Creek channels would be reconstructed as close as possible to premining conditions and dimensions.

The most controversial aspects of the final topography are the comparatively large depressions that would be left by the final cuts, both of which would at least partially fill with water to form lakes. At a water-surface elevation of 3,425 feet, the north lake would cover an area of about 50 acres; the south lake would cover an area of about 110 acres. With the exception of these two final depressions and the lakes that would form, both of which are discussed at length in the following section on water resources, the final surface under Plan B would avoid many of the impacts identified in conjunction with the original proposal. With the exception of the two final depressions, the proposed final topography would approximately restore the original surface configuration and represents a significant improvement over the original proposal.

b. Soils

Under Alternate Plan B, soils would be disturbed and mixed on approximately 2,540 acres or about 365 acres more than would be disturbed under the original proposal. Impacts on the soils would be similar in all respects to those described for the original proposal. Their magnitude would be increased, however, because of the larger area affected. No sodic-soils problems are expected in the East Decker under Alternate Plan B because spoil materials would be replaced in the mined-out area in approximately their premining sequence (p. 710).

c. Water resources

(1) Effects on ground water

The impacts on ground water stemming from implementation of Alternate Mining Plan B in the East Decker area would be generally similar to those described for the original proposal. Some differences, however, would result from (1) the increase in size of the area to be mined, (2) mining closer to the railroad spur and, thus, closer to the Tongue River Reservoir, (3) the appreciable reduction of the length of the initial cuts adjacent to the railroad, and (4) elimination of the box cut adjacent to Deer Creek valley. These modifications are described in the following sections in relation to the impacts discussed under the original proposal.

(a) Removal of aquifers

Mining in the East Decker area under Alternate Plan B would increase the size of the area in which aquifers would be removed by about 17 percent. The aquifers and approximate area from which they would be removed are as follows:

Aquifer	Approximate area to be removed (mi^2)	
	Under original proposal	Under alternate Plan B
Anderson Coal	2	2.5
Dietz 1 Coal	3.5	4.0
Dietz 2 Coal	2	3.8
Sandstone	less than 2	less than 2.5
Clinker	1.5	1.5
Alluvium	less than .5	less than .6

Removal of these aquifers would be accompanied by replacement of spoil materials in the mined-out area. The lowermost spoil materials, which would be moved and placed by dragline, should have significantly greater permeability and porosity than the orignal aquifers (p. 322). No data are available from which to approximate the hydraulic characteristics of the overlying truck-laid spoils, but although undoubtedly less permeable than dragline-laid spoils, they should be at least as permeable and as porous as the original aquifers. Thus, the replaced spoil aquifer as a whole should comprise a replacement aquifer that would store and transmit a larger volume of ground water than the aquifers removed by mining.

(b) Interruption of ground-water flow by the pits

Excavation of the initial cuts for both the north and south pits about 600 feet closer to the Tongue River Reservoir under Plan B would tend to increase ground-water inflow to the mine from the reservoir. That increase, however, would be more than offset by reducing the initial cuts along the western limb to about half the length of the box cut under the original proposal and by eliminating the initial cut along the north margin of the mine area (compare figs. 5 and 77).

The net effect of these changes probably would be to reduce inflow to the mine by as much as 1.0-1.5 ft^3/s initially when only the north pit is opened and by 0.5-1.0 ft^3/s when both the north and south pits are in operation. If so, inflow to the north pit initially should be about 0.5-1.0 ft^3/s. Total inflow to the mine should increase to about 1.0-1.5 ft^3/s after both pits are opened. During the latter stages of mining when the north pit is progressing westward adjacent to Deer Creek valley and the south pit is nearing completion adjacent to the railroad spur, ground-water inflow to the mine might exceed 1.5 ft^3/s, but it appears unlikely that inflow under Plan B would ever equal or exceed that expected under the original proposal (see table 34).

(c) Modification of ground-water flow by replaced spoil materials

As the north pit progresses eastward paralleled by the south pit, which would follow at sufficient distance that one pit operation would not interfere with the other, spoil materials would be replaced in the mined out area so that, in effect, the spoil would be interposed between the active pits and the exposed aquifers contributing inflow along the east side of the Tongue River Reservoir. Greatest inflow to the two pits would be through the alluvium underlying Middle Creek, which would be truncated by the north pit, and the alluvium underlying Coal Creek, which would be truncated by the south pit. It is conceivable that spoil materials would impede the inflow of ground water, especially from the alluvial aquifers that would abut against truck-laid spoils, which should be less permeable than the underlying dragline-laid spoils.

The reduction in flow from the reservoir to the active pits would depend in part on the difference in permeability between the replaced spoil and the alluvium and in part on the hydraulic gradient in the spoil. Although data are generally lacking on the hydraulic properties of replaced spoil materials, very probably the rate of inflow would not be reduced by more than 25 to 50 percent.

The initial impact of the replaced spoil materials on ground-water flow to the Tongue River Reservoir after mining has ended and pumping to dewater the active pits is discontinued should be essentially the same as under the original proposal. Discharge to the reservoir would cease and inflow to the mine area from the reservoir would occur until the spoils are saturated approximately to reservoir level. Because of the larger volume of spoils that would occur under Plan B, a correspondingly longer time might be expected to saturate these spoil materials before ground-water discharge would resume to the reservoir. The effect of the larger volume of spoils, however, may be approximately offset by the reduced porosity of the truck-laid spoils, which would compose the bulk of the replaced materials under Plan B. If so, the time lapsed before ground-water discharge to the reservoir would resume at essentially the premining rate should not be significantly different under Plan B than under the original proposal.

(d) Changes in water quality caused by leaching of spoil materials

Some added degradation in water quality within the mine area normally would be expected under Alternate Plan B because of the larger area disturbed. That effect, however, should be largely, if not wholly, offset by the reduced permeability of the truck-laid spoils that would compose the bulk of the replaced materials under Plan B. Changes in water quality caused by leaching of spoil materials, therefore, should be essentially the same as under the original proposal (see section III. A. 3. a. (4)). In the unlikely event that total dissolved solids entering the Tongue River Reservoir from the East Decker area were increased 15-20 percent under Alternate Plan B, the added impact on the reservoir still would be so small as to have no discernable effect on the use of the reservoir or its water.

(e) Effects of blasting

The 17 percent increase in the size of the area to be mined under Plan B compared to the original proposal and the increased coal production of about 19 percent should increase proportionately the frequency of blasting required. As a result, a corresponding increase in the number of shock waves generated can be expected. This should increase both the incidence of turbidity in nearby wells and the probability of anomolous concentrations of nitrate in the mine effluent. No discernable adverse effect on the quality of water in the reservoir is expected.

(f) Changes in water levels

Enlargement of the area to be mined under Alternate Plan B would increase the number of wells adversely affected from 11 to 12. The additional well (no. 87, table D-1, Appendix D) is on the bottom of Middle Creek valley about 0.4 mile upstream from the southeast margin of the proposed mine area (fig. 43). The water level in this well, which taps a sandstone aquifer within the overburden overlying the Anderson coal bed, should be only minimally affected by the proposed operations. The effects of mining on the other 11 wells should be essentially the same as under the original proposal. No springs would be adversely affected under Alternate Plan B.

(2) Effects on surface water

Most impacts on surface water stemming from implementation of Alternate Plan B in the East Decker area would be signficantly less than those described for the original proposal. Some impacts, however, would be slightly increased because of the larger area to be mined.

(a) Removal of existing stream channels

Mining of 17 percent more area under Alternate Plan B than under the original proposal would require the removal of about 5 percent more natural stream channels. Disturbance of Deer Creek valley, however, would be limited to construction of the railroad loop and sewage lagoons within the loop area. No spoils other than those forming the railroad loop embankment would be placed within Deer Creek valley. The channels and approximate length that would be altered or removed are as follows:

Stream channel	Type of disturbance	Length of valley to be disturbed (miles)	
		Under original proposal	Under Alternate Plan B
Deer Creek	Construction of railroad loop	2.1[1]	0.4
Middle Creek	Channel to be removed	1.7	1.8
Coal Creek	Channel to be removed	1.1	1.15
Other unnamed streams	Channel to be removed	9.2	9.6

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[1] Includes length of valley to be filled locally with spoils.

Impacts from the removal of channels under Plan B would be similar to those described for the original proposal. The magnitude would be increased slightly, however, because of the greater length of channels that would be removed. Conversely, impacts on Deer Creek valley would be greatly reduced inasmuch as about 80 percent less valley length would be disturbed.

(b) Interception and diversion of runoff

Construction of earthern dams and diversion channels to intercept and carry surface runoff around the mine area under Plan B bears little resemblance to the original proposal. Specific design details of the proposed diversion system are presented in section VIII. E. 2. c. (5). Under the original proposal, diversion impoundments would have comparatively little capacity to store flood flows. Most of the runoff from intercepted watersheds, therefore, would be diverted directly into channels designed to carry the peak discharge from a 100-year storm. The inferred result would be locally severe erosion, probable failure of the diversion channels during periods of high discharge, and frequent maintenance requirements. Those impacts would be largely, if not completely, avoided by the diversion system under Plan B. The use of comparatively large impoundments to contain all expected runoff from a 50-year storm of 24-hour duration plus an additional capacity of about 20 percent to provide sediment and low-flow storage is an extremely practical approach. Pumps of suitable capacity would be used to empty the impoundments of all but dead storage in a period of not more than 10 days. The maximum pumped discharge of about 10 ft^3/s through pipelines and diversion channels should present no serious design or erosion problems.

Should one or more of the impoundments fail for any reason, some flooding of the mine probably would occur. Any threat to the safety of men or equipment, however, would be small and environmental damage to the Tongue River Reservoir probably would be less than in the absence of mining.

Deer Creek would not be diverted under Plan B, thereby avoiding the serious impacts that would occur from eventual failure of the diversion system under the original proposal (p. 345). Instead, flows in Deer Creek would pass uninterrupted to the Tongue River Reservoir through culverts installed in the railroad loop embankment. These culverts would be of sufficient size to pass a 50-year flood event. Accordingly, no significant impacts are expected to Deer Creek valley from flooding.

(c) Changes in quantity of water

The added area that would be mined under Alternate Plan B is typical of the Middle Creek and Coal Creek watersheds and probably experiences about 0.4 inch runoff annually. Assuming that runoff to the Tongue River Reservoir from this area both during and after mining would be at least half the premining amount (p.338-339), surface runoff to the reservoir would be decreased only about 12 acre-feet more than under the original proposal as a result of the larger area disturbed. In actuality, most inflow to the diversion impoundments would be pumped into diversion channels that drain to the reservoir or would infiltrate the alluvium underlying the impoundments and eventually reach the reservoir as ground-water flow or as effluent pumped from the active pits. The reduction in runoff to the reservoir because of the modifications in the water-diversion system under Plan B, therefore, should be about the same as under the original proposal.

Of far greater importance are the two final depressions into which most of the runoff from the streams that traverse the mined area would be diverted following the completion of mining operations (fig. 80). On completion of mining and removal of the diversion system, virtually all runoff from a large part of the mined area and from the watersheds upstream, would be retained in these depressions and dissipated by evapotranspiration. Estimated average annual loss of runoff to the Tongue River Reservoir as a result would be about 175 acre-feet (table 15). Although large in comparison to the effects of other aspects of the proposed mining operations on surface runoff, this loss of water to the reservoir represents less than five-hundredths of one percent of total average annual inflow to the reservoir.

(d) Changes in chemical quality of water

Aside from the two lakes that would form in the final cuts, the only additional change in chemical quality of water expected under Alternate Plan B would result from increased leaching of the spoils in the enlarged mine area. The impact of this leachate on the Tongue River Reservoir is discussed on p. 737. The effects of the two final lakes on the quality of surface water are discussed in the following section.

(e) Final lakes

Under Alternate Mining Plan B, the final cuts in the north and south pit areas (fig. 80) would be left as deep depressions that would form two lakes in the final reclaimed surface. The sides of these depressions would be sloped to 20^{o} or less, and exposed coal beds would be covered as required by State and Federal regulations. The lakes and adjacent area would be landscaped to form recreation areas, ownership of which would be transferred from the Decker Coal Co. to the State of Montana.

Hydrologic analysis of the proposed lakes and their utility as recreation areas reveals several apparent deficiencies. Relevant data for the proposed lakes are summarized on p. 711. Assuming an annual evaporation rate of about 40 inches (p. 106) and annual precipitation of about 12 inches (p. 101), net annual evaporation from the lake surfaces should be about 28 inches. Accordingly, annual evaporation losses at a water-surface elevation of 3,425 feet should be about 120 acre-feet for the north lake and about 260 acre-feet for the south lake. Assuming annual runoff from the Middle Creek and Coal Creek watersheds upstream from the mined area to be about 0.4 inch and annual runoff from the reclaimed mine area to be about 0.2 inch, annual runoff to the north lake, which would have a contributing area of about 0.9 mi^2, should be about 10 acre-feet. Annual runoff to the south lake, which would have a contributing area of about 8.9 mi^2, should be about 170 acre-feet.

Ground-water inflow to each lake from the recharge area to the east (fig. 41) probably would average 30-50 acre-feet annually. Most of this inflow, however, would be offset by ground-water movement out of the lakes toward the Tongue River Reservoir should the lake levels be maintained at an elevation of 3,425 feet for recreation purposes. Spillway level of the reservoir is 3,424 feet. Conversely, ground-water movement from the reservoir toward the lakes would occur should the lake levels drop to below the level of the reservoir. Net accretion of water to both lakes from ground-water sources, therefore, would be small when lake levels stand at or above reservoir spillway level (3,424 feet) and would increase significantly when lake levels drop appreciably below the water level in the nearby reservoir.

Clearly, therefore, the north lake would not function satisfactorily as a recreation area. Potential evaporation at a water-level elevation of 3,424 feet is approximately 12 times the estimated inflow from surface runoff. Consequently, the lake level would reach equilibrium only when inflow from both surface runoff and intersected aquifers balances evaporation losses. That level probably would be 25-50 feet below the elevation of the reclaimed surface adjacent to the final cut containing the lake. Moreover, because the lake, in effect, would form both a surface-water and a ground-water sink with no opportunity for removal of soluble constituents, the dissolved solids content of the lake would increase progressively with time. Within a very few years, the water would probably exceed 10,000 mg/l dissolved solids and would be unfit for virtually all uses.

The utility of the south lake is also questionable in that estimated annual inflow from surface runoff is about 35 percent less than expected evaporation losses. It is entirely possible that annual runoff would be greater than 170 acre-feet, but prospects are equally good that runoff would be less than that amount. No assurance exists, therefore, that the ultimate fate of the south lake would not be the same as that of the north lake.

Appropriate mitigating measures that would avoid or minimize the impacts described above are presented in section VIII. E. 5. c. (2).

(f) Erosion and sedimentation

Elements of Alternate Mining Plan B affecting erosion and sedimentation in the East Decker area that differ significantly from the original proposal are: (1) Disturbance of an additional 365 acres (0.57 mi^2), (2) elimination of the Deer Creek diversion system and sediment settling pond as proposed, and construction instead of the railroad loop with culvert pipes so as to cause minimal disturbance to Deer Creek valley, (3) placement of box-cut spoils in areas adjacent to the reservoir (fig. 77) instead of in Deer Creek valley, (4) modification of the water-diversion system and consequent change in the areas of sediment accumulation in the Tongue River Reservoir, (5) Elimination of the highwall in both Middle Creek and Coal Creek valleys, and (6) Diversion of most postmining channels traversing the reclaimed area into depressions left by the final cuts. Impacts stemming from these changes are as follows:

The mining of an additional 365 acres (0.57 mi^2) under Plan B compared to the original proposal would increase the total area disturbed, including plant area, mined area, road relocation, railroad construction, etc., by only about 10 percent. The impacts stemming from this additional disturbance would be the same as under the original proposal; only their magnitude might be increased. If reclamation is successful, as is anticipated, erosion and sediment yield from the additional area disturbed should be no greater than the premining rate. Should establishment of the plant cover be locally unsuccessful, however, sediment yield to the Tongue River Reservoir from eroding parts of the mined area might be several times the premining rate.

Under Alternate Mining Plan B, Deer Creek would not be diverted northwestward through an ancient channel of the Tongue River as under the original proposal, the sediment settling pond at the outlet of the diversion channel would be eliminated, and no spoil materials other than the railroad loop embankment would be placed in Deer Creek valley. Accordingly, all associated impacts would be avoided. Deer Creek would flow through culverts installed in the railroad loop embankment. These culverts would be of sufficient diameter to carry the peak discharge from a 50-year flood. No erosion of the railroad embankment adjacent to the culverts or the channel at the upstream or downstream ends of the culvert should occur during most runoff events. Some scour might occur during peak flows, however, unless adequate protective measures are installed.

Placement of box-cut spoils in areas adjacent to the reservoir (fig. 77) instead of in Deer Creek valley would avoid the almost certain erosion of these materials by Deer Creek once the Deer Creek diversion system as originally proposed eventually failed. The effect would be to decrease long-term sediment yield to the Tongue River Reservoir. Placement of spoils and topsoil stockpiles adjacent to the reservoir would have minimal impact on that water body, provided that all materials are placed above an elevation of 3,430 feet or that adequate protection against wave erosion is provided. Otherwise, appreciable local erosion and consequent increased sediment yield to the reservoir would occur.

Modification of the water-diversion system under Plan B, as proposed, should provide a practical, stable design that would eliminate most, if not all, deficiencies identified in the original proposal. Sediment yield to the Tongue River Reservoir from the mine area and from the Middle Creek and Coal Creek watersheds during operation of the diversion system should be reduced to less than 25 percent of premining rates (table 18). During operation of the diversion system, any sediment passing though the Middle

Creek sediment-settling ponds would enter Deer Creek channel and eventually be deposited in the Tongue River Reservoir at the mouth of Deer Creek valley. Similarly, sediment passing through the Coal Creek diversion system would enter the reservoir at the outlets of the settling ponds near the southwestern corner of the mine area (fig. 81). Sedimentation would no longer occur at the old mouths of Middle Creek and Coal Creek channels. Because the aggrading bottom in this part of the reservoir is commonly exposed during a part of the year (fig. 47B), the above changes in areas of sediment accumulation should have minimal impact on the environment.

Elimination of the highwall in both Middle Creek and Coal Creek valleys and construction of meandering channels having essentially premining parameters should avoid the major impacts on postmining channel stability that would occur under the original proposal. These postmining channels should rapidly adjust to flow conditions and be as stable over the long term as the existing channels.

Postmining diversion of Middle Creek and Coal Creek channels into the final south pit and diversion of most of the northern part of the reclaimed mined area into the final north pit would reduce long-term sediment yield to the Tongue River Reservoir. These deep depressions would function as large settling ponds that would retain all inflow during most years. It is estimated that long-term sediment yield to the reservoir would be reduced by about 4 acre-feet annually.

A potentially serious erosion problem would occur at the mouths of channels entering the final-pit depressions. In the absence of appropriate protective measures, headcuts could form on the oversteeped slopes where the reconstructed channels enter the north and south lakes. Once formed, these headcuts would tend to migrate upvalley, deeply trenching the valley bottoms. Tributary gullies eventually would dissect the valley side slopes and culminate in widespread erosion throughout the reclaimed mine area. Stablization of channel outlets would be complicated by wide fluctuations of lake levels.

(3) An enlarged Tongue River Reservoir

Implementation of Alternate Mining Plan B in the East Decker area and placement of box-cut spoils adjacent to the reservoir (fig. 77) would significantly increase the area of reclaimed spoil materials that would be submerged by construction of a stage I dam and subsequent impoundment of water to an elevation of 3,438 feet. Extensive wave erosion and movement of large volumes of sediment into the enlarged reservoir would occur in the absence of a protective riprap facing.

Although the access road and railroad-embankments would prevent direct flooding of the mine, groundwater inflow to the mine would probably increase to 2-3 ft^3/s. Impacts on the quality of the water in the reservoir from leaching of the spoils should be similar to those described under the original proposal.

Construction of a stage I or stage II reservoir after mining under Alternate Plan B is completed would probably significantly increase the amount of soluble salts leached from the spoils, but the diluting effect of the larger reservoir contents should about offset this impact. Thus, the quality of water in the reservoir probably would not be measurably different from that in the present reservoir. Erosion of the reclaimed spoil embankments would pose a major environmental impact that would require protective measures.

d. Air quality

The mining of an estimated 8 million tons of coal per year would create impacts on air quality for the period of active mining and coal processing. Such impacts would be similar to those described in section III. A. 4. The type of emissions anticipated and the associated atmospheric pollutants would be the same as those discussed on page 361. Fugitive dust and hydrocarbon emissions should be greater under the alternate proposal for the following reasons:

(1) The total length of all haul roads under Alternate Plan B would be about the same or possibly even less than under the original proposal; however, total vehicle miles traveled annually on haul roads would be considerably greater. Fugitive dust generated by vehicular travel on haul roads, therefore, is expected to be greater than under the original proposal.

(2) Average annual tonnages of overburden and interburden material moved would increase under the alternate mining plan, and thus, a proportionally greater amount of dust would be generated by overburden handling.

(3) In addition to a dragline, a truck-shovel fleet would be used to remove overburden and interburden. Under Alternate Plan B, approximately 60 percent of these materials would be moved by the truck-shovel fleet. In effect these materials would be handled twice, once when loaded into the trucks and once when dumped. This double handling most probably would create more dust per ton of spoils moved than a dragline operation, which would handle the materials only once.

(4) Coal dust from coal-processing and loading operations such as size reduction, conveyor transport, and loading would be greater because of the additional 1.3 million tons of coal that would be processed annually under Alternate Plan B.

(5) Particulate and gaseous emissions (primarily hydrocarbons) from diesel-powered trucks would be greater because of the increased numbers of these vehicles that would be used in the mining operation.

e. Vegetation

Mining in the East Decker area under Alternate Plan B would result in the destruction of vegetation on approximately 2,540 acres, or about 17 percent more area than would be disturbed under the original proposal. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated. In the "associated disturbance" areas, the effects on vegetation would range from total destruction in some areas to relatively minor disturbances in others.

Related impacts include the loss of competitive advantage of some deep rooting plants and the loss of vegetation diversity for a period after mining. Both of these impacts are discussed under the original proposal (p. 365-367). Flood plain vegetation within Deer Creek valley would be impacted significantly less under Plan B than under the original proposal. However, this benefit would be at least partially offset by the disturbance of flood-plain vegetation in spoil disposal areas adjacent to the Tongue River Reservoir (fig. 77).

Impacts on grazing and agriculture would be the same as those described for the original proposal (p. 367) because the entire project area, which would be the same as under the original proposal, would be fenced.

Soil and coal dust (air-borne particulates) may influence the existing and reclaimed vegetation in the East Decker area. A discussion of dust-related impacts on reclaimed and native vegetation is presented on pages 367-368.

f. Wildlife

(1) Mammals and birds

(a) Mule deer

Impacts on mule deer under Alternate Plan B would be similar in most respects to those discussed under the original proposal (p. 368). Their magnitude would tend to be incrased because of the larger area to be disturbed, but that effect should be more than offset by significantly reducing the volume of fill placed within the Deer Creek valley. As a result, this habitat, which provides important food and cover for mule deer, would be only minimally impacted under Plan B.

(b) White-tailed deer

The white-tailed deer habitat that would be disturbed under Alternate Plan B is slightly larger than the habitat that would be disturbed under the original proposal because of the permanent placement of spoil materials in low areas adjacent to the Tongue River Reservoir (fig. 77). These reclaimed spoil-disposal areas would reduce flood-plain vegetation in secs. 14, 22, and 23, T. 9 S., R. 40 E. (compare figs. 51 and 77). A consequent loss of white-tailed deer habitat adjacent to the reservoir would occur. This loss, however, would be largely offset by the lesser area of riparian habitat that would be disturbed in Deer Creek valley under Alternate Plan B.

(c) Antelope

Impacts on antelope in the East Decker area under Alternate Plan B would be similar in most respects to those discussed for the original proposal. Their magnitude, however, would be increased somewhat because of the larger acreage to be disturbed, particularly the sagebrush-steppe and mid-short-grass prairie communities. By minimizing the volume of fill placed in Deer Creek valley, Alternate Plan B would be less damaging to the long-term productivity of this valley bottom as a fawn-rearing area.

(d) Sage grouse

Of all game species in the East Decker area, the sage grouse would probably be the most impacted by mining activities. Impacts would be similar in all respects, but slightly more severe than those for the original proposal. Both mining plans would result in a reduction in the number of sage grouse within the East Decker area and possible elimination of all sage grouse in this area. Also, the sage-grouse strutting ground in sec. 7, T. 9 S., R. 41 E., would be destroyed under both plans.

(e) Sharp-tailed grouse, Hungarian partridge, chukar partridge, and ring-necked pheasant

Impacts on these four species would closely approximate those described for the original proposal (p. 370-371).

(f) Geese, ducks, osprey, and shore birds

Impacts on geese, ducks, osprey, and shore birds would be slightly greater than those described for the original proposal inasmuch as spoils excavated from the initial scraper pit would be placed in two areas adjacent to the eastern shore of the Tongue River Reservoir (fig. 77). Other impacts on these species would closely approximate those described for the original proposal (p. 371-372).

(g) Golden eagle, bald eagle and turkey vulture

Impacts on these three large birds would closely approximate those described for the original proposal. A greater area of potential feeding grounds would be removed under Alternate Plan B as compared to the original proposal.

(h) Nongame birds and mammals

Nongame species would be impacted under Alternate Plan B primarily by the loss of habitat. Approximately 17 percent more habitat would be destroyed under Alternate Plan B than under the original proposal for the East Decker area. A discussion of the small mammal species affected is given on page 373.

Primary consumers living in vegetation communities adjacent to the reservoir would be affected by this alternate mining proposal to a greater extent than under the original proposal because of the placement of spoil materials in secs. 14, 22, and 23, T. 9 S., R. 40 E., (fig. 77). Conversely, those species living in Deer Creek valley would be less impacted.

Impacts on resident song and insectivorous birds would be greater than under the original proposal because more acreage would be disturbed.

(2) Fish

The fisheries of the Tongue River Reservoir would be negatively impacted if mining in the East Decker area under Alternate Plan B causes substantial changes in reservoir water quality or sediment load. Specific potential impacts to the fishery resource are discussed on pages 374-375.

Under Alternate Plan B no impact would occur to the important rock bass, smallmouth bass, and crappie spawning area at the outlet of the proposed Deer Creek diversion channel (see fig. 10 and p. 355). Under Alternate Plan B, Deer Creek would not be diverted into the next bay to the north as proposed under the original plan. Instead, Deer Creek would remain in its present channel.

g. Archaeological and historical sites

Mining and associated actitivies would essentially destroy any archaeological sites within the mined area and associated areas disturbed under Plan B. Disturbance of any of those sites identified by Fredlund (1976) in the East Decker area should have minimal impact on man's understanding of the Decker area cultural resources inasmuch as each site has been recorded and evaluated. Important artifacts have been salvaged and preserved. Conversely, mine-related disturbance of any of those sites identified by Lahren (table 33B) prior to appropriate study and recovery of artifacts would result in significant archaeological losses. Impacts to structures and ruins would be the same as those described for the original proposal.

h. Recreational facilities and activities in the Decker area

The impacts on recreational facilities would be essentially the same as those described for the original proposal because the entire East Decker project area would be fenced and because only a comparatively small increase in mine-related employment is anticipated.

Under Alternate Plan B, the Decker Coal Co. proposes to leave two deep pits that would be developed as recreational fisheries (fig. 80). Hydrologic analysis, however, reveals that the two lakes that would be formed probably would be impractical as proposed (see p. 741-743).

i. Aesthetics

Mining in the East Decker area under Alternate Plan B would introduce approximately the same aesthetic impacts as those described for the original East Decker proposal. The magnitude of these impacts would be slightly greater, however, inasmuch as 17 percent additional acreage would be disturbed under Plan B and two large spoil areas would be left adjacent to the Tongue River Reservoir. No changes would occur in the aesthetic impacts caused by the location of loading equipment, the railroad spur, buildings, and coal-processing equipment.

j. Public and access roadways

The primary impact of relocating that part of the county road that lies within the project area (p. 378-379) would be the loss of approximately 43 acres of moderately dry grassland interspersed with isolated pockets of ponderosa pine. This is about 8 acres more than would be lost under the original proposal. Grazable acreage and wildlife habitat would be reduced accordingly under Alternate Plan B.

The short-term decrease in air quality that would occur from construction activities and heavy-equipment vehicular emissions would be only slightly larger than under the original proposal (p. 379). The county road relocation would not be in conflict with the State's Implementation Plan for achieving Federal ambient air-quality standards.

Other road-relocation impacts would be essentially the same as those described on p. 379.

k. Population, local economy, social structure, and social services

No significant changes in the impacts on population, local economy, social structure, and social services are expected if Alternate Plan B for the East Decker mine is approved instead of the original proposal. Mine-related employment (table 47, p. 463) should increase only slightly from that predicted for the original proposal. Approximately 33 additional mine workers would be employed under Alternate Plan B. Accordingly, the economic and social impacts on Sheridan should be increased only slightly.

l. Land use

The area to be fenced in conjunction with the proposed East Decker mine would total approximately 3,715 acres regardless of the mining plan chosen. Impacts on grazing for Alternate Plan B therefore would be the same as those described for the original proposal (see p. 367).

Impacts on land use in the Sheridan area are expected to be the same for Alternate Plan B as for the original plan because the projected population increase for Sheridan would be approximately the same under both proposals.

m. Removal of the coal

An additional 57 million tons of subbituminous low-sulfur coal would be removed from the East Decker area under Alternate Mining Plan B. This action would result in the recovery of all coal within the proposed mine area that occurs in the Anderson, Dietz 1, and Dietz 2 beds, and consequently, the permanent depletion of this fossil-fuel resource. Those deeply buried beds that lie below the depth where they currently can be mined by surface methods would be left undisturbed for possible future development.

n. Long distance transportation of the coal

Transportation of coal from the East Decker mine to the Chicago, Illinois and Austin, Texas areas would be the same as under the original proposal (p. 499-502). The increased production of about 1.3 million tons per year anticipated under Alternate Mining Plan B would increase rail traffic to and from the East Decker mine by about 5 trains per week. Total train traffic over the East Decker spur line, therefore, would be increased from about 13 trains per week to about 18 trains per week. Total train traffic over the Decker spur line to the Burlington Northern main line at Wyarno, Wyoming would be increased from about 73 trains per week to about 78 trains per week. Impacts stemming from this added rail traffic would be the same as those described under the original proposal; their magnitude would be increased proportionately. Impacts of the increased rail traffic on transportation facilities beyond Wyarno, Wyoming cannot be assessed at this time inasmuch as the market area for the increased coal production under Alternate Plan B is not known.

o. Marketing and consumption of the coal

The East Decker mine under Alternate Plan B would be designed to produce about 8 million tons of coal annually. Under existing contracts, about 4 million tons annually would be used by Commonwealth Edison for power generation in the Chicago, Illinois area, and about 2.7 million tons annually would be used by the Lower Colorado River Authority in the Austin, Texas area (p. 506-508). The additional potential production of 1.3 million tons annually anticipated under Plan B has not been committed as of March, 1977. The market area and consumptive use of this coal, therefore, is not known.

p. Other mineral resources

Mining under Alternate Plan B would introduce no additional impacts to mineral resources other than the coal. Those impacts are described in section III. C. 17.

q. Contribution to relief of the energy crisis

The East Decker mine under Alternate Plan B would produce an additional 57 million tons of subbituminous low sulfur coal that would not be mined under the original proposal. This added production--about 1.3 million tons per year--would have an average heating value of about 9,400 Btu/lb and could be used in electric power generation plants to ease the current energy crisis. This anticipated additional production has not been committed to any specific market as of March 1977.

5. Mitigating or compensating measures

a. Topography

Measures that could be used to mitigate impacts on topography in the East Decker area, if mining is initiated under Alternate Plan B, differ from those described under the original proposal (p. 527) primarily in that movement of the bulk of the spoil materials with a truck-shovel fleet would provide much greater flexibility in resculpturing the final surface. The result would be a topography that would approximately follow the original contour as required by State and Federal regulations, except for the two final pits, which would be left as lakes. All ridges and depressions in the mined area would be rounded, and slopes would be reduced to 5 to 1 (20 percent) or less, except for the highwall on the final north and south pits which would be reduced to a slope of 20 degrees (36.4 percent) or less. Principal stream valleys such as those of Middle and Coal Creeks would be reconstructed to essentially their original slope and channel dimensions.

Other possible mitigating measures that could be used, but have not been proposed by the Decker Coal Co., include (1) reduction of slopes, insofar as practicable, to less than 10 percent to promote slope stability and (2) filling the final north pit by using initial box-cut spoils placed adjacent to the reservoir (fig. 77) and fill materials used to construct the railroad, access road and shop and plant areas, all of which must be removed and the areas reclaimed on completion of mining operations. Sufficient materials would not be locally available to fill the south pit. Almost certainly, however, surface-mining operations will eventually occur on tracts bordering the area that would be mined under Alternate Plan B. At that time, which probably would follow closely the completion of mining and reclamation operations in the East Decker area, a disposal area for initial box-cut spoils from the new operations would be needed. The south pit would offer a practical site for the disposal of those spoils.

b. Soils

Proposed and other measures that could be used to mitigate impacts from soil disturbances under Alternate Plan B are the same as those described in section IV. B. 2.

c. Water resources

(1) Ground water

Proposed and other mitigating measures that could be used to minimize impacts on the ground-water system in the larger area to be mined under Alternate Plan B are generally similar to those described under the original proposal (p. 533-547). As under the original proposal, the replaced spoil aquifer should have a higher porosity and hydraulic conductivity than the undisturbed parent rock, and premining patterns and rates of ground-water movement should be approximately reestablished after reclamation is completed and the spoils are once again saturated to reservoir level. Accordingly, no measures would be required to mitigate those temporary impacts.

Mine effluent would be pumped into treatment ponds, and waste water would be evaporated in clay-lined lagoons as under the original proposal. Similarly, ground-water quality and water levels in observation wells would be monitored, and any impacted ground-water supplies would be replaced.

Because of the significant reduction in the size of the active pits under Plan B and an expected corresponding reduction in ground-water inflow, construction of ground-water barriers as described under the original proposal may not be necessary. However, should inflow to the active pits from the nearby reservoir be excessive, ground-water barriers would be constructed as described on page 538 and depicted in figures 67 and 68.

(2) Surface water

The types of mitigating measures that could be used to minimize impacts on surface water under Alternate Plan B would be generally similar to those described in the original proposal (p. 548-563). The magnitude of most measures used to mitigate surface-water impacts, however, would be significantly decreased because of the reduced magnitude of these impacts under Plan B.

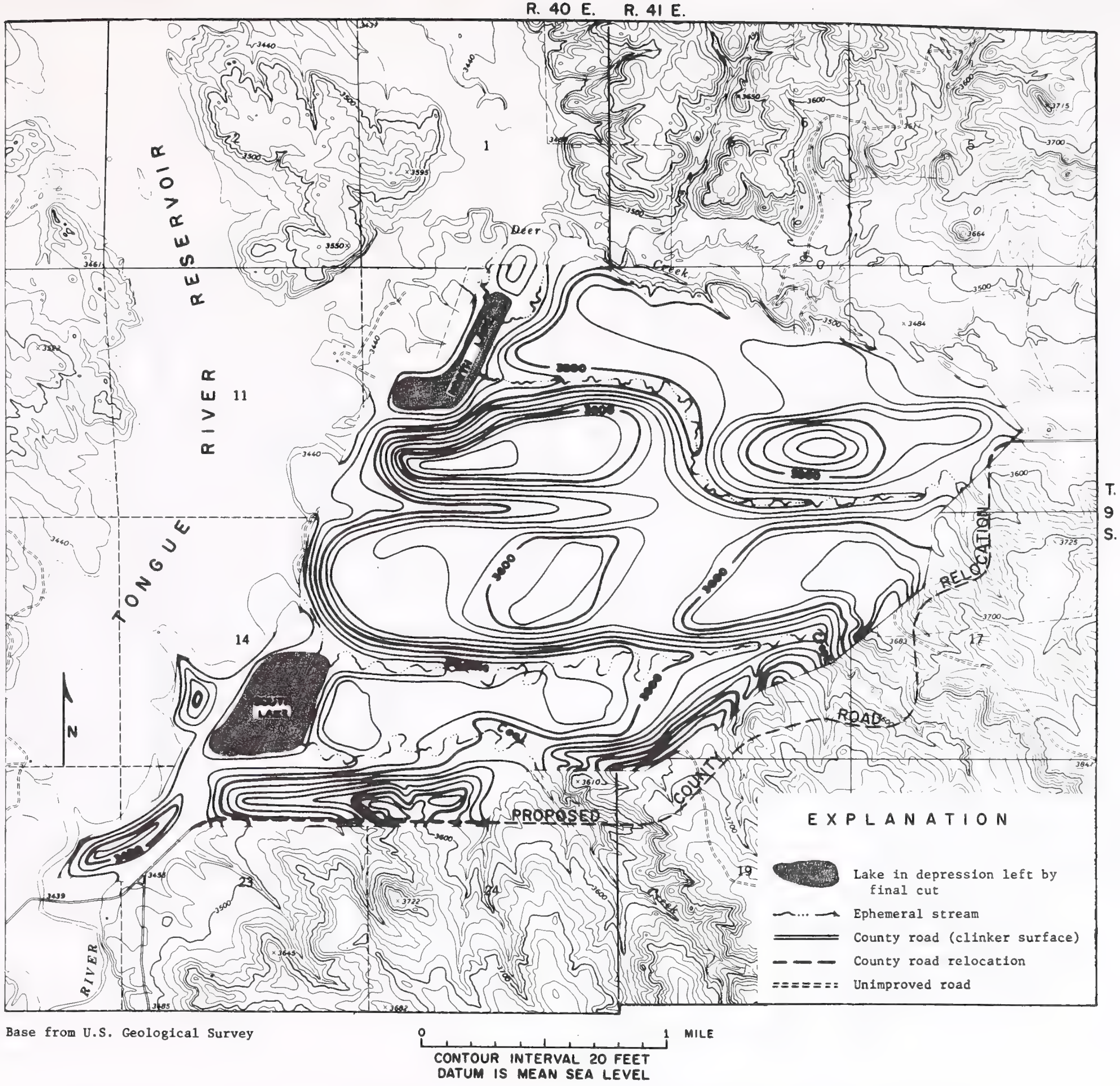
The proposed water-impoundment and diversion system that would be constructed under Alternate Plan B to prevent flooding of the active pits should function essentially as designed and should require comparatively little maintenance over the life of the operations. Discharges of 10 ft^3/s or less in diversion channels should present no significant erosion problems. Local scour could be easily controlled by riprapping any eroding channel reaches with clinker obtained from the mine area (p. 554). Sediment settling ponds as proposed should function adequately and reduce sediment yield to the Tongue River Reservoir from the controlled watersheds by at least 75 percent during the period of mining. Erosion of spoils materials placed adjacent to the reservoir and erosion of the railroad embankment adjacent to the culverts in the Deer Creek channel could be prevented by using clinker to form a protective riprap layer. Other measures used to control erosion or sedimentation would be essentially the same as under the original proposal (p. 549-550).

Middle Creek and Coal Creek channels would be reconstructed in haul-road depressions designed in the final surface. No highwall would be left to disrupt channel gradients, which under Alternate Plan B, would be reconstructed to essentially premining dimensions. Similarly, other channel characteristics such as width, depth, meander pattern, size-distribution of bed material, and roughness would be reconstructed as close as possible to premining conditions.

The Decker Coal Co. proposes to mitigate the impacts stemming from the final pits by diverting surface runoff into these topographic depressions to form lakes that would be utilized as recreation areas (p. 705 and 711). Ownership of the lakes and adjacent landscaped areas would be transferred from the Decker Coal Co. to the State of Montana. A hydrologic analysis (p. 741), however, shows that surface runoff to the north lake would not be adequate for the lake to function as a recreation area, and surface runoff to the south lake would probably be deficient during most years. Accordingly, other measures that could be used to mitigate the impacts that would be introduced by the two final "lakes" are summarized as follows.

North lake:

1. The north pit could be filled on completion of mining with spoil materials obtained from the initial box-cut, the railroad and access road fills, etc. (p. 703).
2. The contributing area to the north lake could be increased from about 0.89 mi^2 to about 1.75 mi^2 by contouring the final surface as shown in figure 83. Although this would approximately double runoff from an estimated 14 acre-feet to 28 acre-feet annually, inflow would still be far short of the expected evaporation rate of about 120 acre-feet annually.



Base from U.S. Geological Survey

Figure 83. — Diversion of additional surface runoff into the north lake after mining under Alternate Plan B in the East Decker area.

3. Sufficient runoff could be obtained by diverting Deer Creek into the North lake as shown on figure 83. Out flow could be directed back into Deer Creek valley so as to enter the old channel a short distance downstream from the point of diversion. Such a diversion would intercept surface water only and would have no adverse effect on ground-water movement in the alluvium underlying Deer Creek valley. The proposed diversion, therefore, would not alter subirrigation of the plant cover on the valley bottom downstream. Such a diversion would also reduce sediment yield to the Tongue River Reservoir by as much as about 10-15 acre-feet annually (table 18) because most of the sediment load carried by Deer Creek would be deposited in the north lake. In the unlikely event that the proposed diversion does not function as expected, Deer Creek could be rerouted in its old channel with minimal effort.
4. A connecting channel could be excavated between the north lake and the Tongue River Reservoir. Such a channel would permit water from the reservoir to enter the north lake during high reservoir stage and vice versa. Natural flushing of accumulated salts and consequent preservation of water quality would result. An excavated channel would have a limited life expectancy in the absence of continued maintenance, however, because of sediment accumulation in the upper part of the reservoir (fig. 47B) and because

of the frequent reworking of these sediments by wave action. Wave action in the southeastern part of the reservoir is augmented by the prevailing northwesterly winds in the Decker area.

5. Erosion at the mouths of channels entering the north pit could be prevented by decreasing the slope of the edge of the pit as much as possible and by using very coarse clinker rubble to disperse inflow and slow the velocity sufficiently to induce aggradation rather than erosion.

South lake:

1. Materials would not be available to fill the south pit on completion of mining, but fill materials might be obtained from adjacent new mining operations (p. 757-758).
2. The adequacy of runoff to the south lake from the Middle Creek and Coal Creek watersheds could be determined by establishing a surface-water monitoring network on these drainages. Monitoring would be simplified by measurement of runoff into the impoundments that would be constructed as part of the diversion system.
3. A connecting channel could be excavated between the south lake and the Tongue River Reservoir similar to the one described for the north lake. Such a channel would probably eventually fill with sediment in the absence of continued maintenance.
4. Peak flows in the Tongue River could be skimmed off and diverted into the south lake through a constructed diversion

channel. This approach, however, may be unfeasible because of complications introduced by existing water rights, rights-of-way, etc.

5. Same as no. 5 for the north lake.

(3) An enlarged Tongue River Reservoir

Mitigating measures that could be used to minimize impacts of an enlarged reservoir on the mine and impacts of the mined area on an enlarged reservoir are the same as those described under the original proposal (p. 562-563).

d. Air quality

(1) Compliance with existing regulations

Regulations that would be used to mitigate impacts to air quality under Alternate Plan B are the same as those described in section IV. B. 4.

(2) Proposals of the Decker Coal Co. and other possible mitigating measures

The Decker Coal Co. proposes to use a water spray during the primary coal crushing process to better suppress dust emissions during that and the subsequent coal-handling and coal-loading processes at the East Decker plant facility. Approximately 84,000 gallons per day would be consumed in the spraying process and would leave the plant area in the coal. Other measures that would mitigate impacts to air quality in the East Decker area are essentially the same as those described in section IV. B. 4.

e. Vegetation and wildlife

Proposed and other measures that could be used to mitigate impacts to vegetation and wildlife under Alternate Plan B are the same as those described in sections IV. B. 5. and IV. B. 6.

f. Population, land use, economics, social structure, and social services

Proposed measures suggested for mitigating impacts to population, land use, economics, social structure and social services under Alternate Plan B are the same as those described in sections IV. C. 2., IV. C. 3., IV. C. 4., and IV. C. 5.

g. Archaeological and historical sites

Proposed measures suggested for mitigating impacts to archaeological and historical sites under Alternate Plan B are the same as those described in section IV. C. 6.

h. Recreational facilities and activities in the Decker area

Under Alternate Plan B the final cuts in the north and south pit areas would be left as deep depressions that would form two lakes in the reclaimed surface (fig. 80). Decker Coal Co. has proposed that these lakes be developed as fisheries and that the adjacent areas be developed for recreational purposes. Available hydrologic data, however, indicate that runoff to these lakes, as proposed, would be inadequate to offset evaporation losses. Without additional mitigating measures, use of the lakes and adjacent areas for recreational purposes probably would be impractical. For further discussion of the final lakes see pages 760-764. Other proposed measures for mitigating impacts to recreational facilities and activities in the Decker area are the same as those described in section IV. C. 7.

i. Aesthetics

Proposed measures for mitigating impacts to aesthetics under Alternate Plan B are the same as those described in section IV. C. 8.

j. Long-distance transportation of the coal

Mitigating measures that could be used to minimize impacts stemming from long distance transportation of coal from the East Decker area under Alternate Plan B are the same as those described under the original proposal (p. 619-621).

6. Adverse impacts that cannot be avoided if Alternate Mining Plan B is adopted

a. Depletion of natural resources

(1) Coal and superjacent minerals

Approximately 192 million tons of subbituminous, low-sulphur coal would be removed from the East Decker area under Alternate Plan B. This is about 57 million tons more coal than would be mined under the original proposal. The coal removed would represent a permanent depletion of a fossil fuel resource, which would be about 0.07 percent of the total coal resources of Montana and about 0.46 percent of the stippable coal resources (p. 622).

A moderate amount of clinker would be intermixed with other spoil materials in the additional area to be mined and thereby lost to future use as a construction material in the immediate area. This loss would be insignificant, however, because of the vast amount of clinker in the surrounding area. No other mineral deposits are known to occur in the area.

(2) Water resources

(a) Ground water

If Alternate Plan B is implemented, all aquifers within the mined interval in the East Decker area would be removed. Approximate areas of aquifers removed under the original and alternate proposals are given on page 734. Existing aquifers would not be physically altered outside the mined area. Within the mined areas, they would be replaced by a single aquifer that should be capable of storing and transmitting larger amounts of ground water than the removed aquifers.

The rate of water loss to the Tongue River Reservoir during the period following mining when the spoil aquifer is being saturated should not be significantly different from that under the original proposal. This loss might be as much as 3-5 acre-feet/day initially and would decrease progressively with time. Because of the larger volume of spoils to be saturated under the alternate plan, however, the time required to saturate the spoil aquifer to approximately premining ground-water levels should be correspondingly greater. It might take as long as 20-25 years before ground-water discharge resumes to the reservoir at essentially the premining rate.

Ground water moving through the replaced spoil aquifer should increase appreciably in dissolved solids content as a result of leaching of soluble materials in the spoil. Some leaching is expected during the period of mining; the greatest deterioration in water quality, however, should occur after mining when the spoil aquifer is saturated to approximately premining levels and movement is once again toward the Tongue River Reservoir. The dissolved solids content of the water is expected to increase from about 2,500 mg/1 before mining to as much as 6,000 mg/1 after mining. The sodium adsorption ratio probably would be more than 50. Because of dilution, the effect of this deterioration in water quality on the use of the Tongue River Reservoir or its water should be insignificant and probably would be difficult to measure by standard sampling and testing procedures.

(b) Surface water

Mining the larger area under Alternate Plan B would result in the removal of an additional 1.15 miles of stream channels. The lengths of the respective valleys that would be removed are listed on page 738.

Some small additional decrease in runoff to the Tongue River Reservoir may occur as a result of mining the additional area, but the amount should not exceed a few acre-feet annually and would be insignificant compared to total annual inflow to the reservoir.

b. Topography

Alteration of the topography in an additional area of about 365 acres cannot be avoided if Alternate Plan B is implemented. Because the surface would be lowered by removal of the coal (p. 627), the topography cannot be restored to its original configuration. The final surface, however, would approximate the original contour. The proposed topography and drainage in the East Decker area after reclamation is completed under Alternate Plan B are shown in figure 80.

c. Soils

Soils would be removed, mixed, altered, and replaced on approximately 2,540 acres disturbed directly by mining and related activities. Some minor soil disturbances would occur in adjacent areas from offroad vehicle travel and other activities indirectly related to the proposed operations. Short-term and possibly some long-term effects of reduced productivity, permeability, infiltration capacity, and depth of the disturbed soils are unavoidable.

d. Air quality

The major unavoidable adverse impact to air quality would be the minor amounts of coal and soil dust created by surface disturbances in the mine area. The operation of mining and coal-processing equipment, haulage trucks, locomotives, and other mine-related machinery would emit gaseous and particulate pollutants into the airshed. This would cause a reduction of air quality on the proposed mine sites and downwind during the period of mining (VTN Colorado, 1975b).

e. Vegetation

Unavoidable adverse impacts to vegetation include destruction of 2,540 acres of rangeland in the short-term and changes in species composition and community size and location in the long-term.

Soil or coal dust may adversely affect the existing or reclaimed vegetation in the East Decker area.

f. Wildlife

(1) Mammals and birds

All species of wildlife which utilize areas that would be disturbed by mining activities would suffer habitat losses at least in the short-term. Human activity associated with the mining operation also would impose some unavoidable short-term impacts. For those species which tolerate or readily adapt to increased human activity, impacts would be less severe. Species such as antelope and sage grouse, which have very explicit habitat requirements and do not tolerate increased human activity, may be severly affected for a long period of time. The degree and duration of impact would depend on the length of the mining operation and the timing and success of reclamation.

(2) Fish

If potential soil erosion, sedimentation, or other water-resources contamination are controlled, no unavoidable adverse impacts on the fisheries in the Tongue River Reservoir should occur under Alternate Plan B for the East Decker area.

g. Loss of forage

By fencing the proposed mine boundaries, 3,715 acres of grazing land, representing a livestock carrying capacity of approximately 500 AUM'S, would be lost for at least the duration of the project's life. This displacement would slightly reduce the output of farms and ranches in Big Horn County until such time as successful reclamation is achieved. If range productivity on the reclaimed mine areas is not as high as or better than that before mining, the productivity of the mine areas for raising livestock would have been sacrificed for mineral production.

h. Economics

A principal adverse, unavoidable economic impact as discussed in section V. H. is the disparity between the governmental revenue surpluses that would accrue to Big Horn County and the State of Montana and the governmental revenue deficits that would occur in Sheridan County and the State of Wyoming. Such inequities, because of institutional constraints, are inevitable and there is little hope of solving them in the near future.

i. Social structure and social services

Because total mine-related employment should increase only slightly from that predicted for the original proposal (table 47), adverse, unavoidable impacts upon housing, quality of life, social values, and community services should be approximately the same as those discussed in section V. I.

j. Aesthetics

During the period of mining under Alternate Plan B, all impacts to the aesthetic environment would be unavoidable and adverse. The length of time that these impacts persist would depend on the success of reclamation. Any residual man-made facilities remaining after mining may also unavoidably and adversely affect the aesthetic quality of the area.

Population growth in this rural area of the Northern Great Plains could adversely affect the aesthetic environment of the area long after the coal has been mined because of the increased human activity. It is impossible to predict the long-term effects of population increases at this time.

k. County road relocation

An unavoidable loss of grazing forage and wildlife habitat would result from the 4.35 miles of county-road relocation proposed under Alternate Mining Plan B. This loss may be short-term, however, depending on the success of reclamation on the completion of mining.

Short-term decreases in air, water, and noise quality would be anticipated during construction. Unnoticed archaeological values could also be destroyed during construction.

l. Train traffic

Big Horn County has no current plans to construct a grade-separation structure on the county road where it would cross the proposed railroad spur line to the East Decker mine. Obstruction of county-road traffic at this crossing by about 18 trains per week, therefore, would be an unavoidable impact as a result of the proposals. A similar impact would occur at the Wyarno crossing (p. 500) on Wyoming Highway 336 until the Wyoming Highway Department or the Burlington Northern constructs an overpass or underpass at that location. No such structure is planned by the Highway Department for the near future (p. 619). The Burlington Northern Railroad in a letter to the Powder River Basin Resource Council (Appendix M) also disclaims any obligation on its part to construct a grade-separation structure at the Wyarno crossing. Burlington Northern argues that funds for such projects purportedly are available at the State and Federal levels.

Other unavoidable impacts as a result of increased train traffic are identical to those described for the original proposal (see p. 634).

F. Alternate mining plan for the North Extension area

1. Background

In 1963 when the Decker Coal Co. obtained Federal lease, Montana 057934, it was thought that the coal was entirely burned in sec. 34, T. 8 S., R. 40 E. and in the E½ sec. 3, T. 9 S., R. 40 E. Consequently, that area was not included in the lease (fig. 1). Subsequent test drilling in 1972-75, however, established that the Dietz 2 coal bed very probably is not burned in this area, and possibly the Anderson-Dietz 1 bed may not be entirely burned in some parts of the area. Nevertheless, the Decker Coal Co. elected to proceed with its original mining plans and forego any development of this additional coal rather than to delay mining operations in the North Extension area until the additional lease could be obtained.

As apparent unleased coal reserves in sections 3 and 34 are not considered sufficient to warrant independent development, very probably this coal would be lost to future use unless it is mined in conjunction with other reserves in the North Extension area. In the interests of conservation, the Decker Coal Co. was advised by the U.S. Geological Survey and the Montana Department of State Lands to file appropriate lease applications with the Bureau of Land Management and to prepare an alternate mining plan that could be adopted should a lease be obtained prior to initation of mining under the original proposal. In response to that request, the Decker Coal Co. on August 8, 1975, applied for modifications of two of its Federal Coal leases. Under this application, Federal lease, Montana 057934, would be enlarged to include 320 acres in the E½ sec. 3, T. 9 S., R. 40 E. Federal lease, Montana 057934-A, would be enlarged to include 400 acres in the W½ and the S½NE¼ sec. 34, T. 8 S., R. 40 E. (fig. 1). The Decker Coal

Co. subsequently withdrew its application for the above lease modifications when passage in 1976 of the Federal Coal Lease Amendment Act, P.L. 94-377, limited the area that could be incorporated into an existing lease to a maximum of 160 acres. Instead, the Bureau of Land Management tentatively will hold a competitive coal lease sale for these 720 acres in May 1977. The Decker Coal Co. will be an active participant in that sale.

On October 28, 1975, an alternate mining plan containing the following proposals was submitted by the Decker Coal Co. for evaluation by the Area Mining Supervisor, U.S. Geological Survey, and by the Montana Department of State Lands. This alternate plan would be used if the Company is successful in its attempt to obtain a lease for those additional coal resources in sections 3 and 34. On February 22, 1977, the Decker Coal Co. submitted a restructured copy of this alternate mining plan to the Area Mining Supervisor for evaluation of its conformance to revised Federal Regulations 30 C.F.R. 211 adopted May 17, 1975. The Area Mining Supervisor has evaluated this plan for conformance with the requirements of 30 C.F.R. 211.10(c), and he has found that it meets those requirements.

2. Description of the proposals

a. Description of the coal

A total of about 61 million tons of coal, about 2 million tons per year, would be mined in the North Extension area under the alternate plan. This represents an increase of about 14 million tons or about 30 percent more coal than would be recovered under the original proposal. The rate of mining of about 2 million tons per year, however, would be the same as under the original proposal. The life of the mine, therefore, would be extended about 7 years. An estimated additional 2 million tons would be obtained from the Anderson-Dietz 1 bed and an estimated additional 12 million tons would be obtained from the Dietz 2 bed. Analyses of coal from the Anderson-Dietz 1 bed and the Dietz 2 bed in the North Extension area are given in table B-4, Appendix B.

b. Mining sequence and procedures

An initial north-trending box cut spanning the full width of the mine would be made adjacent to and separated from the Tongue River Reservoir at spillway level by a buffer zone, the width of which would be established by the Montana Department of Natural Resources and Conservation. The approximate location of this box cut and several succeeding turnover cuts is shown on figure 84. As mining progresses westward from the box cut, the pit would be separated by a haulage and dragline ramp into the northern and southern pits, each independent of the other as in the original proposal. The rate of mining advance on each pit would depend on the quality of the coal and the amount of blending required to meet customer specifications of 9,500 Btu/lb. The Northern limit of the mine in section 34 would be controlled by the bluffs along the north side of Spring Creek valley. Extension of the mine eastward into the E½ section 3 would permit additional recovery of coal in the N½NE¼ section 10. Other limits of mining would be the same as under the original proposal.

Overburden would be stripped using the 41-yard dragline presently in use at the West Decker mine (fig. 16). Spoils from the box cut would be placed east on the reservoir side of the cut for its entire length using the procedure shown previously in figure 15. Sufficient distance generally would be left between the toe of the spoils and the reservoir at spillway level to prevent wave erosion and leaching of the spoil materials. An exception would be in the E½ section 3 where the upper ends of two small embayments near the mouth of Pearson Creek would be filled with spoils if the box cut is located as shown in figure 84.

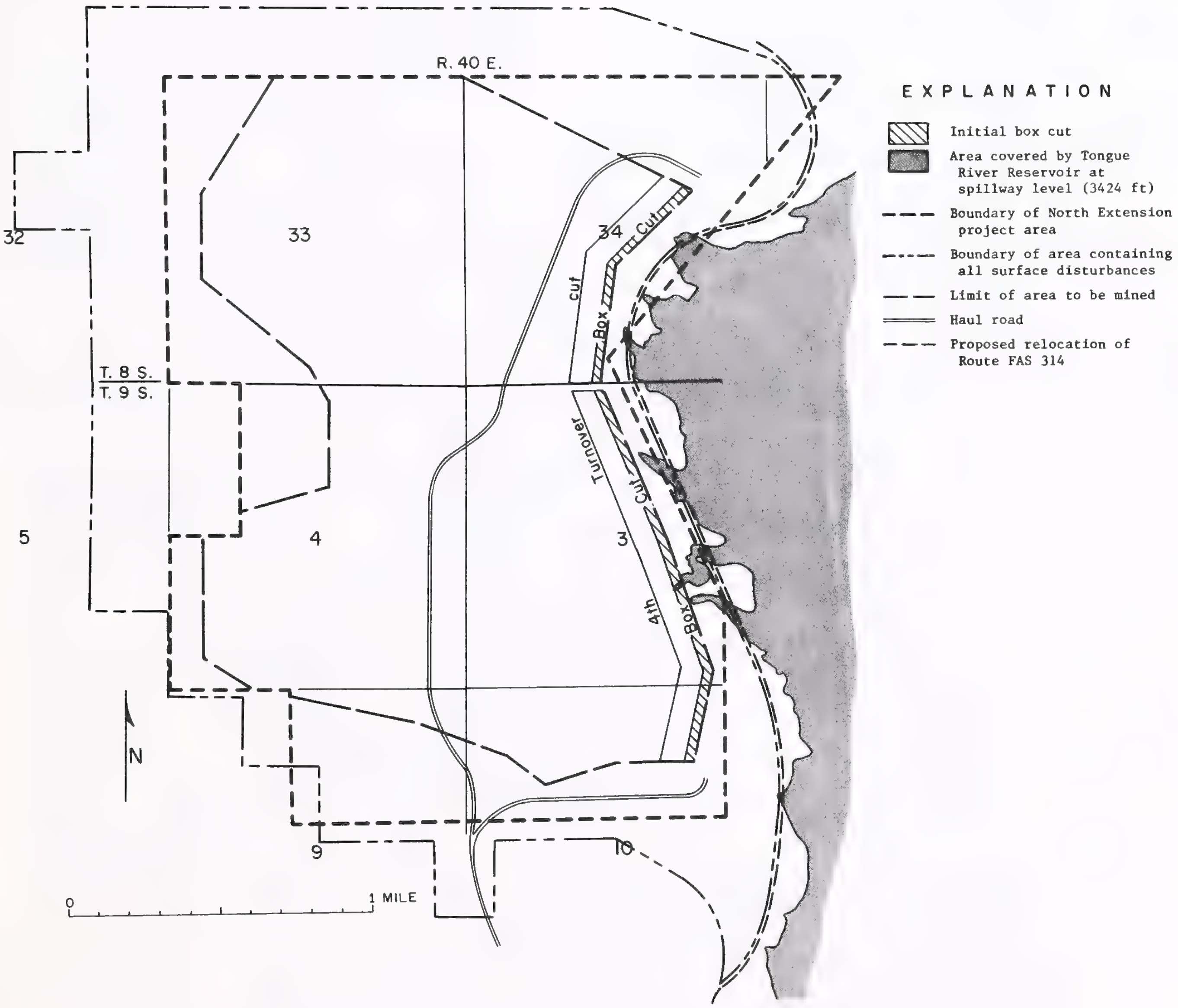

R. 40 E.
32
33
34
T. 8 S.
T. 9 S.
5
4
3
9
10
Box cut
Cut
Turnover
Cut
4th
Box
N
0
1 MILE
EXPLANATION
▨ Initial box cut
■ Area covered by Tongue River Reservoir at spillway level (3424 ft)
Boundary of North Extension project area
Boundary of area containing all surface disturbances
Limit of area to be mined
Haul road
Proposed relocation of Route FAS 314

Figure 84.—Alternate mining sequence and location of roads in the North Extension area.

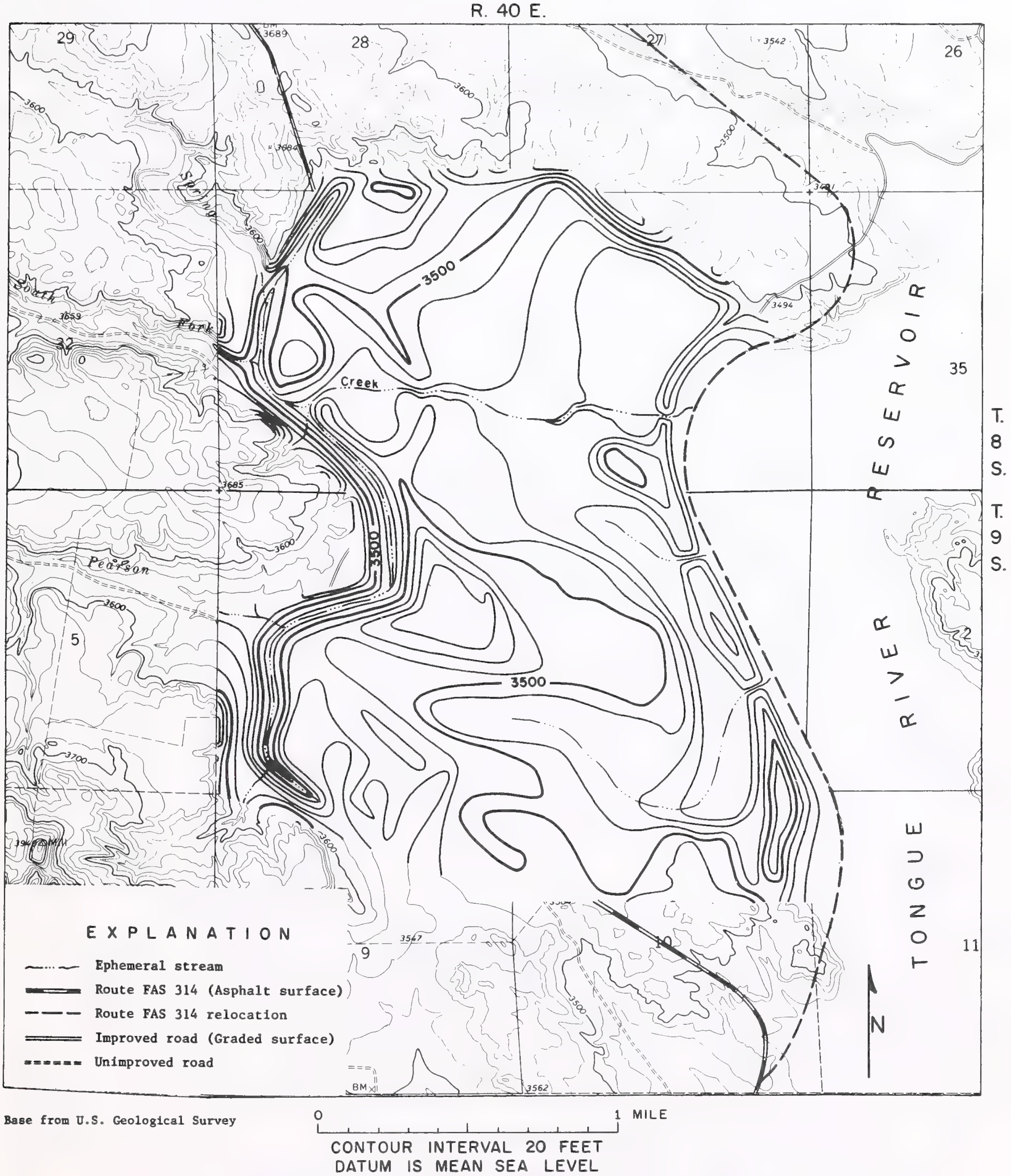
Reclamation procedures would be essentially the same as those described under the original proposal.

(1) Reclaimed topography

The proposed topography after mining is shown in figure 85. It differs from the original proposal primarily in that the reclaimed surface includes those additional areas that would be mined under the alternate proposal. Surface drainage across the reclaimed surface would be essentially the same as under the original proposal.

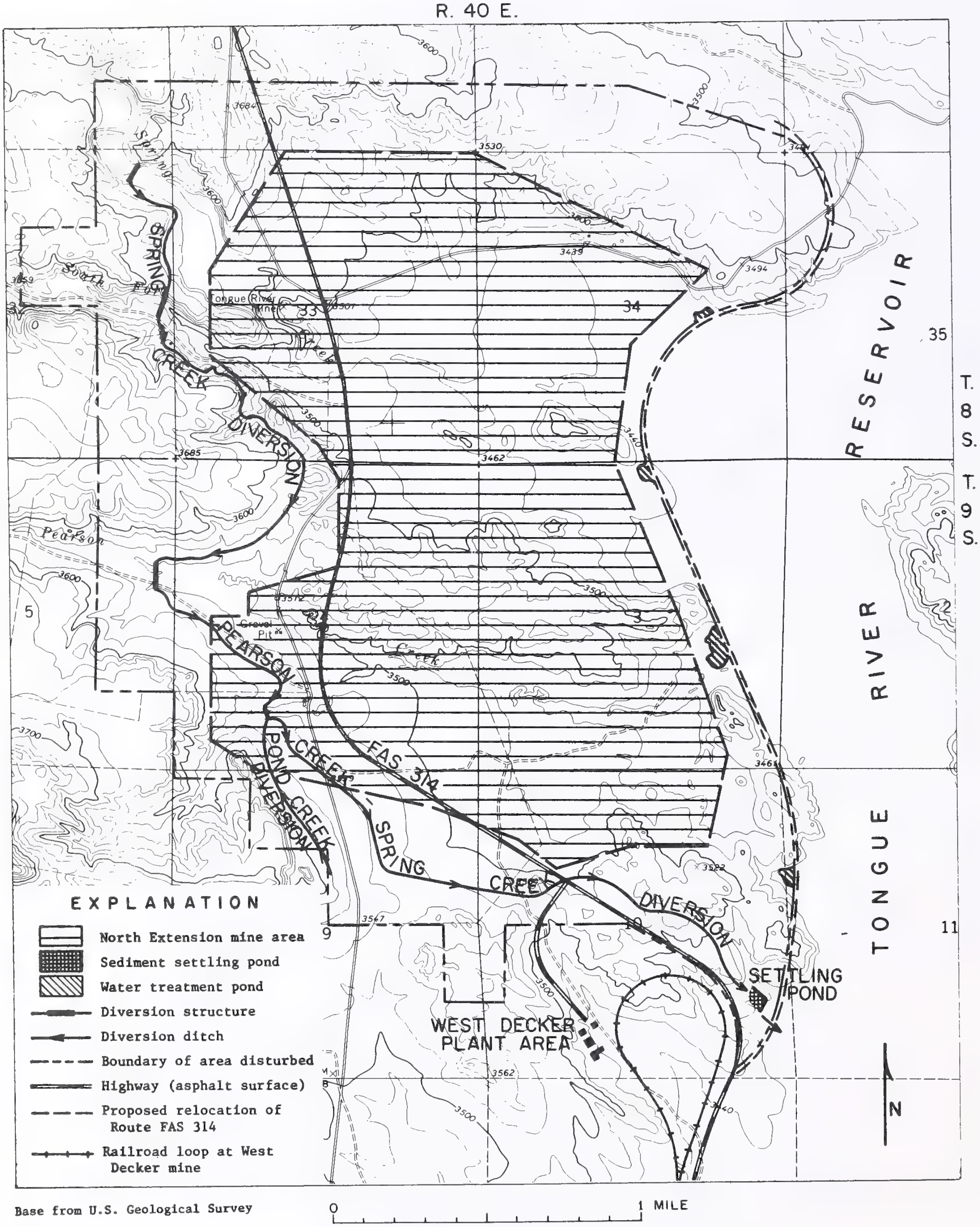
(2) Water diversion and impoundment

The alternate mining plan, under which the north and south pits would not be initially separated, requires a change in the water-diversion system from that described in the original proposal (p. 68-74). Spring Creek could not be diverted between the two pits in initial and secondary phases as originally planned (fig. 20). Instead, the flow must be routed generally southward into the Pearson Creek drainage around the south side of the mine area (fig. 86). Impoundments would be built on Spring and South Fork Spring Creeks as proposed in phase two of the original proposal (p. 71), and used to divert flow into a channel designed to carry 1,800 ft^3/s. This channel, in turn, would discharge into the impoundment and diversion on Pearson Creek (fig. 86). Outflow from the Pearson Creek diversion would be in a channel designed similarly to the one described in the original proposal (p. 71-73), but enlarged so as to carry the additional runoff from the Spring Creek watershed. Similarly, the settling pond at the outlet of this channel would be enlarged to accommodate the additional flow. On completion of mining and reclamation, Pearson Creek would be routed northward and become a tributary of Spring Creek, which would approximately follow its original course eastward to the Tongue River Reservoir (fig. 85).



Base from U.S. Geological Survey

Figure 85.—Proposed topography and drainage after mining under the alternate plan in the North Extension area.



Base from U.S. Geological Survey

Figure 86.-Proposed water-diversion system and highway relocation for the alternate mining plan in the North Extension area.

Surface runoff within the mine area and ground-water inflow to the pits would be pumped to the closest of four settling ponds located between the initial box cut and relocated Route FAS 314 (fig. 86). Outflow from these ponds to the Tongue River Reservoir would be through pipes under the highway.

Water for dust control, an estimated 80,000 gal/day, would be obtained from the settling ponds.

c. Mining facilities and equipment

Plant and loading facilities at the existing West Decker mine would be used as in the original proposal. Equipment would be the same. Relocation of Route FAS 314 would follow the west shoreline of the Tongue River Reservoir as in the original proposal. The distance between the shoreline and the roadway, however, would probably be less than under the original proposal to allow room for spoil materials excavated from the box cut.

3. Description of the environment

The existing environment in the North Extension area, including the additional area that would be disturbed under the alternate plan, is described in section II.

4. Environmental impacts of the proposals

Adoption of the alternate mining plan would result in the mining of about 32 percent more area than would be mined under the original proposal. Accordingly, the environmental impacts generally would be greater than under the original proposal, but not necessarily proportionately so.

a. Topography

The proposed reclaimed surface would differ from that in the original proposal primarily in the disturbance of an additional 450 to 500 acres and in the formation of a curved elongate ridge along the west side of the Tongue River Reservoir instead of two offset, elongate north-trending ridges from 0.2 to 1.2 miles west of the reservoir (compare figs. 19 and 85). The elongate ridge would be formed by reclaimed spoil materials excavated from the initial box cut. It would be about 2.1 miles long, 500 to 1,500 feet wide at the base and 50 to 100 feet high. Side slopes would be moderately steep, averaging 10 to 20 percent. Slopes of this magnitude would be subject to excessive sheet and rill erosion unless they are protected by a good plant cover and by appropriate land-treatment practices.

The reclaimed surface in the western part of the mined area would be the same as that described in the original proposal (p. 381) and would have the same impact on the environment. The depression left by the final cut would have side slopes ranging from 20 to 36 percent that would average about 25 percent. These slopes, like those formed by reclamation of the box-cut spoils, would be subject to accelerated erosion unless they are adequately protected. As in the original proposal, Pearson Creek valley would not be retained as a topographic feature of the reclaimed surface. Because of the elimination of Pearson Creek valley as a principal drainage course and the creation of a potentially unstable eroding surface characterized by a prominent ridge along the west side of the Tongue River Reservoir and an elongate depression on the west margin of the mined area, the proposed reclamation plan would not approximately restore the original, essentially stable surface configuration.

b. Soils

Under the alternate mining plan, soils would be disturbed and mixed on approximately 1,850 acres or 450 to 500 acres more than would be disturbed under the original proposal. Impacts on soils would be similar in all respects to those described for the original proposal. The magnitude of the impacts would be increased, however, because of the larger area affected.

No additional sodic-soils problems are expected in the added area that would be mined under the alternate plan.

c. Water resources

(1) Effects on ground water

The impacts on ground water stemming from implementation of the alternate mining plan in the North Extension area would be similar in most respects to those described for the original proposal. Some differences, however, would result from (1) the increase in size of the area to be mined and (2) excavation initially of a single box cut located generally closer to the reservoir than the two separate box cuts in the original proposal. These modifications are described in relation to the impacts discussed under the original proposal.

(a) Removal of aquifers

The alternate mining plan in the North Extension area would increase substantially the size of the area in which aquifers would be removed during mining. The aquifers and approximate area from which they would be removed are as follows:

Aquifer	Approximate area to be removed (mi^2)	
	Under original proposal	Under alternate mining plan
Clinker	1.5	2.1
Alluvium	.5	.9
Anderson-Dietz 1 coal	1	1.1
Dietz 2 coal	2	2.7

Removal of these aquifers would be accompanied by replacement of spoil materials in the mined-out area. As all spoils would be moved and placed by dragline, the permeability and porosity of these materials should be significantly greater than the permeability and porosity of the original aquifers. Thus, the replaced spoil aquifer should comprise a replacement aquifer that would store and transmit a larger volume of ground water than the aquifers removed by mining.

(b) Interruption of ground-water flow by the pit

Under the alternate mining plan, all but a small part of the initial box cut would be excavated closer to the Tongue River Reservoir than under the original proposal (compare figs. 13 and 84). Estimates of ground-water inflow to the active pit were made using the same methods of calculation as those used to evaluate the original proposal. These estimates are summarized in table 57.

Contrary to expectations that inflow would increase as the pit is moved closer to the reservoir, calculations indicate that ground-water inflow to the mine would be about 30 percent less under the alternate plan than under the original proposal. This apparent anomoly can be explained largely by the location of the initial box cut in relation to the elevation of the base of the clinker. Drill-hole data indicate that the base of the clinker is higher adjacent to the reservoir than farther west in the vicinity of the northern and southern box cuts described under the original proposal. Thus, the increase in inflow that normally would occur because of the increased hydraulic gradient as the pit is moved closer to the reservoir would be more than offset in this case by the decrease in the saturated thickness of the clinker. Also, the box cut under the alternate plan is actually about 500 feet farther from the reservoir than the north end of the southern pit under the original proposal (fig. 67). As this is an area of inferred maximum inflow to the mine and the base of the clinker does not slope westward

Table 57. -- Estimated inflow of ground water during and after construction of the initial box cut in the proposed North Extension mine under the alternate mine plan.

Elapsed time from start of construction (days)	Length of box cut (feet)	Estimated Inflow							
		From Tongue River Reservoir (ft^3/s)		From aquifer discharge (ft^3/s)		From aquifer storage (ft^3/s)		Total (ft^3/s)	
		Low	High	Low	High	Low	High	Low	High
5	100	--	--	--	--	4.3	5.4	4.3	5.4
85	2,100	2.0	3.1	0.2	0.3	2.9	3.1	5.1	6.5
125	3.600	2.6	3.6	.3	.4	1.1	1.2	4.0	5.2
140	4.100	2.7	3.7	.3	.4	.7	.8	3.7	4.9
165	4,900	2.8	3.7	.4	.5	.8	.9	4.0	5.1
190	5,700	2.8	3.7	.4	.6	.6	.7	3.8	5.0
230	7,100	2.8	3.8	.7	.9	1.1	1.3	4.6	6.0
260	7,700	3.4	4.8	.9	1.2	2.2	2.3	6.5	8.3
335	10,500	3.7	5.0	1.2	1.6	1.2	1.4	6.1	8.0
365	11,100	3.8	5.1	1.2	1.6	.7	.8	5.7	7.5
730 1/	11,100	3.8	5.1	1.2	1.6	.4	.5	5.4	7.2
1825 2/	11,100	3.8	5.1	1.2	1.6	.2	.3	5.2	7.0

1/ One year after completion of initial box cut

2/ Five years after start of initial box cut appreciably in this area, inflow would be significantly less in this part of the pit under the alternate plan.

The decreased inflow to the mine under the alternate plan would result in decreased mine effluent and a corresponding decrease in environmental impacts.

(c) Modification of ground-water flow by replaced spoil materials

Replacement of spoil materials in the mined-out area between the active pit and the Tongue River Reservoir should have little effect on ground-water inflow to the mine. Dragline-laid spoil derived largely from clinker and alluvium should be more permeable than the same materials in their undisturbed state.

The initial impact of the replaced spoil materials on the flow of ground-water to the Tongue River Reservoir after mining has ended and pumping to dewater the mine is discontinued should be essentially the same as under the original proposal. Discharge to the reservoir would cease, and inflow to the mine area from the reservoir would occur until the spoils are saturated approximately to reservoir level. Because of the larger volume of spoils that would occur under the alternate plan, however, a correspondingly longer time would be required to saturate these spoil materials before ground-water discharge would resume to the reservoir. Thereafter, discharge to the reservoir would resume at essentially the premining rate.

(d) Changes in water quality caused by leaching of spoil material

Some added degradation in water quality within the mine area would be expected under the alternate plan because of the larger area disturbed. Ground-water discharging from the spoil aquifer might contain as much as

2,500 mg/1 dissolved solids and have a sodium adsorption ratio of as much as 12. Dominant ions probably would be sodium and sulfate.

During mining, the impact on the Tongue River Reservoir of any increase in dissolved solids content under the alternate plan should be more than offset by the reduction in mine effluent. After mining is completed and ground-water discharge resumes to the reservoir at approximately the premining rate, the total dissolved solids entering the reservoir from the North Extension area might be increased as much as 25 percent. The added impact on the reservoir, however, would be so small as to have no discernable effect on the use of the reservoir or its water.

(e) Effects of blasting

The same tonnage of coal would be mined annually under the alternate plan. The frequency and consequent effects of blasting, therefore, would not be changed by adoption of the alternate plan. The duration of these effects, however, would be extended about 7 years.

(f) Changes in water levels

Enlargement of the area to be mined under the alternate plan would not increase the number of wells adversely affected, but would increase the severity of the impact on several of these wells. Four additional wells (nos. 24, 25, 26, and 46; p. 396) would be physically destroyed, increasing the total number of wells destroyed to nine. The effect on the remaining wells would be essentially the same as under the original proposal. In addition to the impact on the wells, one additional spring (no. 3, p. 397) would be eliminated, because it lies within the area to be mined. Also, the remaining spring in the area (no. 4, p. 397) would probably stop flowing during the period of mining.

(2) Effects on surface water

The impacts on surface water stemming from implementation of the alternate plan in the North Extension area would be generally similar to those described for the original proposal. The principal differences would be the larger area to be mined and the excavation of a single box cut, which would require modification of the diversion system described under the original proposal.

(a) Removal of existing stream channels

The alternate plan in the North Extension area would increase the length of natural stream channels that would be removed by mining. The channels and approximate length that would be removed are as follows:

Stream channel	Length of valley to be removed (miles)	
	Under original proposal	Under alternate mining plan
Spring Creek	1.4	1.9
South Fork Spring Creek	.3	.3
Pearson Creek	2.0	2.3
Other unnamed streams	3.5	4.8

Impacts from the removal of these channels would be similar to those described for the original proposal; the magnitude of the impacts would be increased, however, because of the greater length of channels that would be removed.

(b) Interception and diversion of runoff

Construction of earthen dams and diversion channels to intercept and carry surface runoff around the mine area would introduce impacts generally similar to those described for the original proposals. Although no specific design details of the proposed diversion system are presented in the alternate plan, the proposal indicates that diversion impoundments constructed on the principal streams would be the same as those described in phases I and II of the original proposal and that channels would be designed similar to those in the original proposal. If so, it follows that the diversion impoundments should function adequately. The diversion channels, however, would be subject to flow velocities up to about 8 ft/s in earthen materials and up to about 43 ft/s in concrete-lined reaches. These velocities would be moderately erosive in the weathered clinker materials, which underlie the surface throughout most of the North Extension area, and highly erosive in the alluvium underlying the bottoms of stream valleys crossed by the diversion channels. Concrete-lined reaches would be subject to the same problems described under the original proposal.

Diversion of the combined runoff from the Spring Creek and Pearson Creek watersheds into a single channel constructed around the south side of the mine (fig. 86) should introduce no added impacts to the area, provided that the channel is adequately designed and constructed. Impacts on the Tongue River Reservoir are described on page 785.

The impacts of secondary ditches and small impoundments constructed within the mine area should be essentially the same as under the original proposal.

(c) Changes in quantity of water

The added area that would be mined under the alternate proposal is underlain by moderately to highly permeable clinker and alluvium and probably averages somewhat less than 0.2 inch runoff annually. It is doubtful, therefore, that runoff from this part of the mined area would be significantly decreased by mining. If so, the change in quantity of surface water discharged to the Tongue River Reservoir as a result of mining should be essentially the same as under the original proposal (p. 401). Total loss of water to the reservoir as a result of mining in the North Extension area is estimated to be about one-hundredth of 1 percent of total annual inflow to the reservoir during the period of mining and less than one-hundredth of 1 percent of total inflow to the reservoir after mining.

Tongue River mine lake and the nearby spring in the bottom of South Fork Spring Creek valley would be eliminated as sources of water for livestock and wildlife as described under the original proposal. In addition, the two springs in sec. 34, T. 8 S., R. 40 E., would be adversely affected by mining (p. 397). The loss would be minimized, however, by the close proximity of the Tongue River Reservoir (fig. 43).

(d) Changes in chemical quality of water

The only additional change in chemical quality of water expected under the alternate plan would result from increased leaching of the spoils in the enlarged mine area, followed by discharge of this leachate to the Tongue River Reservoir. The impact of this water on the reservoir is discussed on p. 785.

(e) Erosion and sedimentation

Elements of the alternate plan affecting erosion and sedimentation that differ significantly from the original proposal are: (1) Elimination of the phase I diversion system on Spring Creek, (2) diversion of the combined flows of the Spring Creek and Pearson Creek watersheds around the south side of the mine area (3) elimination of the settling pond in the lower reach of Spring Creek valley and enlargement of the settling pond near the outlet of the combined Spring Creek-Pearson Creek diversion channel, (4) disturbance and reclamation of an additional 450 to 500 acres, (5) placement of box-cut spoils closer to the Tongue River Reservoir, (6) removal of the lower channel reach in Spring Creek valley, and (7) change in areas of sediment accumulation in the Tongue River Reservoir. Impacts stemming from these changes are as follows:

Elimination of the phase I diversion system and construction instead of diversion impoundments on Spring and South Fork Spring Creek channels at the outset of mining might significantly reduce the sediment yield to the Tongue River Reservoir during the first 8 to 10 years of mining, depending on the trap efficiency of the impoundments and the erosional stability of the diversion channels downstream from the impoundments. Conversely, it is unlikely that the change in the diversion system under the alternate plan would increase sediment yield to the reservoir. Most probably, a small, comparatively insignificant reduction in sediment yield would occur because of this change.

Construction of a single diversion channel to carry the combined runoff from the Spring Creek and Pearson Creek watersheds around the mine area would not in itself increase channel erosion and consequent sediment yield to the Tongue River Reservoir. An essentially stable channel could be designed and constructed to carry the estimated peak discharge from these watersheds. Experience shows, however, that the higher the peak discharges, the more difficult it generally is to build a stable channel that will function properly over a wide range of flow conditions. The impact on the reservoir should be inconsequential, however, if the settling pond near the outlet is of adequate size and properly maintained.

Elimination of the settling pond in the lower reach of Spring Creek valley and construction of a larger pond near the outlet of the combined Spring Creek-Pearson Creek diversion channel should have no adverse impact on the reservoir, providing the enlarged pond is properly designed and constructed.

The added impact from mining the larger area depends on the outcome of the reclamation process. If reclamation is successful, as is anticipated, erosion and sediment yield from the additional area disturbed should be no greater than the premining rate. Should establishment of the plant cover be locally unsuccessful, however, sediment yield to the Tongue River Reservoir from eroding parts of the mined area might be several times the premining rate.

Placement of the box-cut spoils closer to the Tongue River Reservoir at a lower elevation might result in some additional sediment yield to the reservoir, but direct erosion of these reclaimed spoil materials by wave action would be prevented by the intervening relocated Route FAS 314 (fig. 85).

Removal of the lower channel reach in Spring Creek valley followed by restoration of the surface at a lower slope would reduce the possibility of postmining erosion in this reach by the combined flows of Spring and Pearson Creeks.

Under the alternate plan, sediment from the Spring Creek watershed during the period of mining would enter the reservoir at the outlet of the diversion channel instead of at the mouth of Spring Creek. This is tentatively regarded as a beneficial impact because the outlet of the diversion channel is in an area where the aggrading reservoir bottom is commonly exposed during a part of the year (fig. 47B). Additional sediment in this part of the reservoir should have minimal impact on the environment.

Weighing all the foregoing factors affecting erosion and sedimentation, it is doubtful that mining the larger area outlined in the alternate plan would significantly increase or decrease erosion in the North Extension area. Similarly, consequent sediment yield to the Tongue River Reservoir, either during or after mining, should not be changed significantly.

(3) An enlarged Tongue River Reservoir

Implementation of the alternate mining plan in the North Extension area and placement of box-cut spoils closer to the reservoir at a lower elevation would significantly increase the area of reclaimed spoil materials that would be submerged by construction of a stage I dam and subsequent impoundment of water to an elevation of 3,438 feet. Extensive wave erosion and movement of large volumes of sediment into the enlarged reservoir would occur in the absence of a protective riprap facing.

Although the ridge formed by excavation of the box-cut spoils would prevent direct flooding of the mine, ground-water inflow to the mine would probably increase to somewhat more than 20 ft^3/s. Impacts from leaching of spoils materials on the reservoir water should be similar to those described under the original proposal.

Construction of a stage I or stage II reservoir after mining is completed under the alternate plan would probably increase the amount of soluble salts leached from the spoils by as much as 30 percent, but the diluting effect of the larger reservoir contents should about offset this impact. Thus, the quality of water in the reservoir probably would not be measurably different from that in the present reservoir. Erosion of the reclaimed spoil embankments would pose a major environmental impact that would require protective measures.

d. Air quality

The mining of an estimated two million tons of coal per year would create impacts on air quality for the period of active mining. The major air-pollutant emissions expected from this alternate mining operation are the same as those described in the original proposals inasmuch as the rate of surface disturbance and coal production are nearly identical under the two plans. Because of removal of an additional 14 million tons of coal under the alternate plan, however, air quality impacts caused by mine-related activities can be expected to last for approximately seven years longer than under the original proposal.

e. Vegetation

Mining in the North Extension area under the alternate plan would result in the destruction of vegetation on approximately 2,060 acres or about 54 per cent greater area than would be disturbed under the original proposal. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated. In the "associated disturbance" area, the effects on vegetation would range from total destruction in some areas to relatively minor disturbances in others.

Related impacts include the loss of competitive advantage of some deep-rooted plants and the loss of vegetative diversity for a period after mining.

Both of these impacts are discussed under vegetation impacts for the North Extension proposal (section III. B. 5. b.).

The impacts on grazing would be the same as those described in section III. B. 5. b. inasmuch as the entire project area, which is the same as that described in the original proposal, would be fenced. The impacts on agriculture would be considerably greater under this alternate mining plan, however, as 437 acres of irrigated cropland would not only be taken out of production but would be completely destroyed by the strip-mining process.

Soil and coal dust (air-borne particulates) may influence the premining or reclaimed vegetation in the North Extension area. A discussion of dust impacts on reclaimed and native vegetation is presented in section III. A. 5. c.

f. Wildlife

(1) Mammals and birds

(a) Mule deer, white-tailed deer, and antelope

The impact on these three species under the alternate North Extension mining plan would be similar in most respects to those discussed for the original mine proposal for the North Extension area (section III. B. 6). The magnitude of such impacts, however, would be somewhat greater because of the larger mine area to be disturbed.

(b) Sage grouse

Of all the game species in the North Extension area, the sage grouse would probably be the most impacted by mining activities. Impacts would be similar in all respects, but more severe, than those for the original proposal.

(c) Sharp-tailed grouse

Mining operations would eventually destroy the 437 acres of irrigated cropland within the proposed North Extension mine area, thereby removing alfalfa as a food source and cover for sharp-tailed grouse. To date, however, few sharptails have been observed within either the proposed original or alternate mine area.

(d) Hungarian partridge, chukar partridge, ring-necked pheasant, great blue heron, and double-crested cormorant

Impacts on these five bird species are essentially the same as those described for the original mining plan.

(e) Geese, ducks, and shore birds

Implementation of the alternate mining plan for the North Extension area would result in the destruction of the seasonal stubble fields in secs. 33 and 34, T. 8 S., R. 40 E. These stubble fields are a principal feeding area for geese in the vicinty of the Tongue River Reservoir.

Other impacts on geese, ducks, and shore birds under the alternate North Extension mining plan would be similar to those discussed under the original mine proposal. The magnitude of such impacts, however, would be somewhat greater because of the larger mine area to be disturbed and, in particular, because of the increase in mine activity in areas a quarter of a mile or less from the reservoir.

(f) Osprey

Impacts on the osprey would be nearly identical to those discussed under the original mining plan.

(g) Golden eagle, bald eagle, and turkey vulture

Impacts on these three large birds would closely approximate those described for the original proposal. A greater amount 450-500 acres of potential feeding areas would be removed under the alternate plan as compared to the original proposal.

(h) Nongame birds and mammals

Nongame species would be impacted under the alternate plan primarily by additional loss of habitat. Approximately 54 percent more potential habitat acreage would be destroyed under the alternate plan than under the original proposal for the North Extension area. A discussion of the small-mammal species affected is given on p. 429.

Mine operations would decrease available nesting and feeding areas for many of the resident song and insectivorous birds. The density of breeding birds within the proposed mining area does not appear to be heavy, and it is possible that displaced birds would use areas outside the mine boundary for nesting and feeding.

(2) Fish

The fisheries of the Tongue River Reservoir could be adversely impacted if mining in the North Extension area causes substantial changes in reservoir water quality or sediment load. This is not expected, however. Specific potential impacts to the fishery resource are discussed in section III. B. 6. b.

g. Archaeological and historical sites

Mining and associated activities would essentially eliminate any archaeological sites within the North Extension mine area and areas of associated disturbance. With the exception of site no. 24BH1525, disturbance of any of those sites identified by Fredlund (1976) in the North Extension area should have minimal impact on man's understanding of the cultural resources in the Decker area inasmuch as all sites except the one above have been recorded and evaluated. Important artifacts have been salvaged and preserved. The possibility of significant loss of subsurface material still exists at site 24BH1525. Accordingly, the disturbance of this site by mining prior to subsurface testing could result in the permanent loss of archaeological resources.

Except for the collection of two bifaced fragments, the four sites identified by Lahren in the North Extension area have only been observed (table 33B). Should mining disturb these sites prior to appropriate study and recovery of artifacts, significant archaeological resources could be lost.

Given the number of archaeological sites discovered by both Fredlund and Lahren, it is highly probable that additional sites not located in either survey would also be destroyed by mining under the alternate mining plan in the North Extension area. Thus, a possibility remains that a significant undiscovered archaeological site may be destroyed.

No structures or ruins within the North Extension project area are listed in the National Register of Historic Places, nor has any structure or ruin within the project area been so nominated. The only old structures within the project area are those associated with the Tongue River mine, and these are neither of historic nor architectural significance (Murray, 1973).

h. Recreational facilities and activities in the Decker area

The impacts on recreational facilities would be similar to those described for the original proposal inasmuch as the North Extension project area would be fenced the same as under the original proposal and no change in mine-related employment is anticipated.

Under the alternate mining plan for the North Extension area, mining would occur approximately three-quarters of a mile closer to the Tongue River Recreation area (fig. 87) than under the original proposal. Therefore, noise, air-quality, and aesthetic impacts on reservoir and Recreation Area users would be more severe.

i. Aesthetics

Mining in the North Extension area under the alternate plan would have approximately the same aesthetic impacts as those described for the original proposal. The magnitude of such impacts would be increased, however, as approximately 54 percent more acreage would be disturbed by strip mining.

j. Highway relocation

Realignment of Route FAS 314 under the alternate mining plan for the North Extension area (fig. 87) closely approximates the alignment shown in the proposal (fig. 20). The impacts of such a realignment are discussed in section III. B. 10.

k. Population, local economy, social structure, and social services

No significant changes in the impacts on population, local economy, social structure, and social services are expected if the alternate plan for the North Extension mine is approved instead of the original proposal. As mine-related employment (table 47) should be the same as that predicted for the original proposal, the economic and social impacts on Sheridan also should be the same.

l. Land use

Approximately 6,040 acres would be fenced in the East Decker and North Extension areas regardless of the mining plans chosen. The impacts on grazing for the alternate North Extension mining plan, therefore, are the same as those described in section III. C. 8.

Impacts on land use in the Sheridan area are expected to be the same for the alternate North Extension mining plan as for the original mining plan. The projected population increase for Sheridan would remain the same under both proposals.

5. Mitigating or compensating measures

a. Topography

Proposed and other measures that could be used to mitigate impacts on topography in the North Extension area are the same as those described under the original proposal (p. 527). The larger area to be mined would require the reclamation of an additional 450 to 500 acres, but the methods used would be the same.

b. Soils

Proposed and other measures that could be used to mitigate impacts from soil disturbances under the alternate plan are the same as those described in section IV. B. 2.

c. Water resources

(1) Ground water

Proposed and other mitigating measures that could be used to minimize impacts on the ground-water system in the larger area to be mined under the alternate plan are essentially the same as those described under the original proposal (p. 533-548). An exception would be the use of a single continuous compacted-fill barrier to retard ground-water inflow to the mine from the nearby Tongue River Reservoir (fig. 67). Computations indicate that such a barrier would effectively reduce inflow to the mine by about 50 percent. The effects of such a barrier on ground-water movement, both during and after mining, are described on pages 538-545.

(2) Surface water

Mitigating measures that could be used to minimize impacts on surface water are essentially the same as those described under the original proposal (p. 512-562). Mining the larger area under the alternate plan would not change the kinds of impacts that would occur -- only their magnitude.

(3) An enlarged Tongue River Reservoir

Mitigating measures that could be used to minimize impacts of an enlarged reservoir on the mine and impacts of the mined area on an enlarged reservoir are the same as those described under the original proposal.

d. Air quality, vegetation, and wildlife

Proposed and other measures that could be used to mitigate impacts to air quality, vegetation, and wildlife under the alternate plan for the North Extension area are the same as those described in sections IV. B. 4., IV. B. 5., and IV. C. 1.

e. Population, land use, economics, social structure and social services

Measures proposed that would mitigate impacts to population, land use, economics, social structure, and social services under the alternate plan for the North Extension area are the same as those described in sections IV. C. 2., IV. C. 3., IV. C. 4., and IV. C. 5.

f. Archaeological and historical sites

Proposed measures suggested for mitigating impacts to archaeological and historical sites under the alternate plan for the North Extension area are the same as those described in section IV. C. 6.

g. Recreational facilities and activities in the Decker area

Proposed measures suggested for mitigating impacts to recreational facilities and activities in the Decker area under the alternate plan for the North Extension area are the same as those described in section IV. C. 7.

h. Aesthetics

Proposed measures suggested for mitigating impacts to aesthetics under the alternate plan for the North Extension area are the same as those described in section IV. C. 8.

6. Adverse impacts that cannot be avoided if the alternate mining plan is adopted

a. Depletion of natural resources

(1) Coal and superjacent minerals

An additional 14 million tons of subbituminous, low-sulphur coal would be removed from the North Extension area under the alternate plan. This would represent a permanent depletion of a fossil fuel resource, which would be about 0.005 percent of the total coal resources of Montana and about 0.03 percent of the stippable coal resources (p. 622).

An indeterminate amount of clinker would be intermixed with other spoil materials in the additional area to be mined and thereby would be lost to future use as a construction material in the immediate area. This loss would be insignificant, however, because of the vast amount of clinker in the surrounding area. No other mineral deposits are known to occur in the area.

(2) Water resources

(a) Ground water

If the alternate plan is implemented, all aquifers within the mined interval in the North Extension area would be removed. Approximate areas of aquifers removed under the original and alternate proposals are given on page 781. Existing aquifers would not be physically altered outside the mined area. Within the mined areas, they would be replaced by a single aquifer that should be capable of storing and transmitting larger amounts of ground water than the removed aquifers.

The rate of water loss to the Tongue River Reservoir during the period following mining when the spoil aquifer is being saturated should not be significantly different under the original and alternate proposals. This loss might be as much as 18 to 24 acre-feet/day initially and would decrease progressively with time. Because of the larger volume of spoils to be saturated under the alternate plan, the time required to saturate the spoil aquifer to approximately premining ground-water levels would be correspondingly greater. It might take as long as 20 years before ground-water discharge resumes to the reservoir at essentially the premining rate.

Ground water moving through the replaced spoil aquifer should increase appreciably in dissolved solids content as a result of leaching of soluble materials in the spoil. Some leaching is expected during the period of mining; the greatest deterioration in water quality, however, should occur after mining when the spoil aquifer is saturated to approximately premining levels, and movement is once again toward the Tongue River Reservoir. The dissolved solids content of the water is expected to increase from about 1,500 mg/1 before mining to as much as 2,500 mg/1 after mining. The sodium adsorption ratio probably would increase from less than 5 to as much as 12. The effect of this deterioration in water quality on the use of the Tongue River Reservoir or its water should be insignificant and probably would be difficult to measure by standard sampling and testing procedures.

(b) Surface water

Mining the larger area under the alternate plan would result in the removal of an additional 2.1 miles of stream channels. Channels removed include those in the lower reaches of Spring Creek and Pearson Creek valleys and those in four comparatively small unnamed ephemeral stream valleys. The lengths of the respective valleys that would be removed are listed on p. 786.

Some small additional decrease in runoff to the Tongue River Reservoir may occur as a result of mining the additional area, but the amount should not exceed a few acre-feet annually and would be insignificant compared to total annual inflow to the reservoir.

Leaching of spoils in the larger area that would be mined under the alternate plan would probably increase the dissolved solids content of ground-water discharged from the mined area, both during and after mining, by as much as 25 percent. It is doubtful, however, that consequent degradation of water quality in the reservoir could be measured by standard sampling procedures and laboratory methods. Because of dilution, the impact on the use of the reservoir or its water should be insignificant.

b. Topography

Alteration of the topography in an additional area of about 450 acres cannot be avoided if the alternate plan is implemented. Because the surface would be lowered by removal of the coal (p. 627), the topography cannot be restored to its original configuration. The proposed topography and drainage in the North Extension area after reclamation is completed under the alternate plan are shown in figure 85.

c. Soils

Soils would be removed, mixed, altered, and replaced on approximately 1,850 acres disturbed directly by mining and related activities. Some minor soil disturbances would occur in adjacent areas from offroad vehicle travel and other activities indirectly related to the proposed operations. Short-term and possibly some long-term effects of reduced productivity, permeability, infiltration capacity, and depth of the disturbed soils are unavoidable. Increased soil losses from erosion and increased sediment yield to the Tongue River Reservoir would occur, but their magnitude cannot be determined from available data.

d. Air quality

The major unavoidable adverse impact to air quality would be minor amounts of coal and soil dust created by the surface disturbance in the alternate mining area. The operation of mining equipment, haulage trucks, and other mine-related machinery would emit gaseous and particulate pollutants into the airshed. This would cause a reduction of air quality on the proposed mine site and downwind (VTN Colorado, 1975b).

e. Vegetation

Unavoidable, adverse impacts to vegetation include destruction of 2,060 acres of range and cropland in the short term and changes in species composition and community size and location in the long term.

Soil or coal dust may adversely affect the unmined or reclaimed vegetation in the North Extension area.

f. Wildlife

(1) Mammals and birds

All species of wildlife which utilize areas that would be disturbed by mining activities would suffer habitat losses at least in the short term. Human activity associated with the mining operation also would impose some unavoidable short-term impacts. For those species which readily adapt to or tolerate increased human activity, impacts would be less severe. Species such as antelope and sage grouse, which have very explicit habitat requirements and do not readily tolerate increased human activity, may be severly affected for a long period of time. The degree and duration of impact would depend on the length of the mining operation and timing and success of reclamation.

(2) Fish

If potential soils erosion, sedimentation, or other water-resources contamination are controlled, there should be no unavoidable adverse impacts on the fisheries in the Tongue River Reservoir as a result of the alternate mining plan for the North Extension area.

g. Loss of forage

By fencing the proposed mine boundaries, 2,325 acres of grazing land representing a livestock carrying capacity of approximately 500 AUM's, would be lost for at least the duration of the project's life. This displacement would slightly reduce the ouput of farms and ranches in Big Horn County until such time as successful reclamation is achieved. If range productivity on the reclaimed mine area is not as high as or better than that before mining, then the productivity of the mined area for raising livestock would have been partially sacrificed for mineral production.

h. Economics

A principal adverse, unavoidable economic impact as discussed in section V. H. is the disparity between the governmental revenue surpluses that would accrue to Big Horn County and the State of Montana, and the governmental revenue deficits that would occur in Sheridan County and the State of Wyoming. Such inequities, because of institutional constraints, are inevitable, and there is little hope of solving them in the near future.

i. Social structure and social services

Since total mine related employment (see table 47, p. 463) should not differ from that predicted for the original proposal, impacts upon housing, quality of life, social values, and community services should be identical to those discussed in section V. I.

j. Aesthetics

During the period of mining in accordance with the alternate plan for the North Extension mine, all impacts to the aesthetic environment would be unavoidable and adverse. The length of time that this situation persists would depend on the success of the reclamation. Any residual man-made facilities remaining after mining may also unavoidably and adversely affect the aesthetic quality of the area.

k. Highways

An unavoidable loss of grazing forage and wildlife habitat would result from the relocation of Route FAS 314. This loss may be short term, depending on the success of reclamation efforts by the applicant on surface previously occupied by the respective right-of-ways.

A decrease in the aesthetic values held by reservoir users may be unavoidable because of potential reactions to the visual impact of the Decker Coal Co.'s proposed secondary alignment.

Short-term decreases in air, water, and noise quality would be anticipated during mine construction. Unnoticed archaeological values may be destroyed during construction.

G. Highway relocation alternates for the North Extension mine area

1. Description of alternate routes

The length of the relocation proposed by the Decker Coal Co. is 6.46 miles compared to 5.07 miles between common points when traveling on the existing highway. Because of this additional length and the consequent increased cost to the road user and the additional maintenance required by Big Horn County, an investigation was undertaken by the Montana Highway Department to determine the feasibility of other, possibly shorter routes between common points. Possible alternates are:

a. West alternate route

A location immediately west of the proposed North Extension and existing West Decker mine boundaries was considered. Such an alternate would decrease the distance traveled (fig. 87); however, suitable horizontal and vertical alignments would be difficult to achieve owing to the ruggedness of the terrain.

The Decker Coal Co. has advised the State that a relocation to the west could jeopardize potential mine expansion should the coal in the area become more economically feasible to mine in the future. In addition, coal and surface rights in the area immediately west of the Decker Coal Co. operations are held by companies active in energy development whose plans are not known at this time. In light of the above, it would appear that a highway relocation to the west would introduce more problems than the proposed alternate route. The west alternate route, therefore, is given no further consideration in this impact statement.

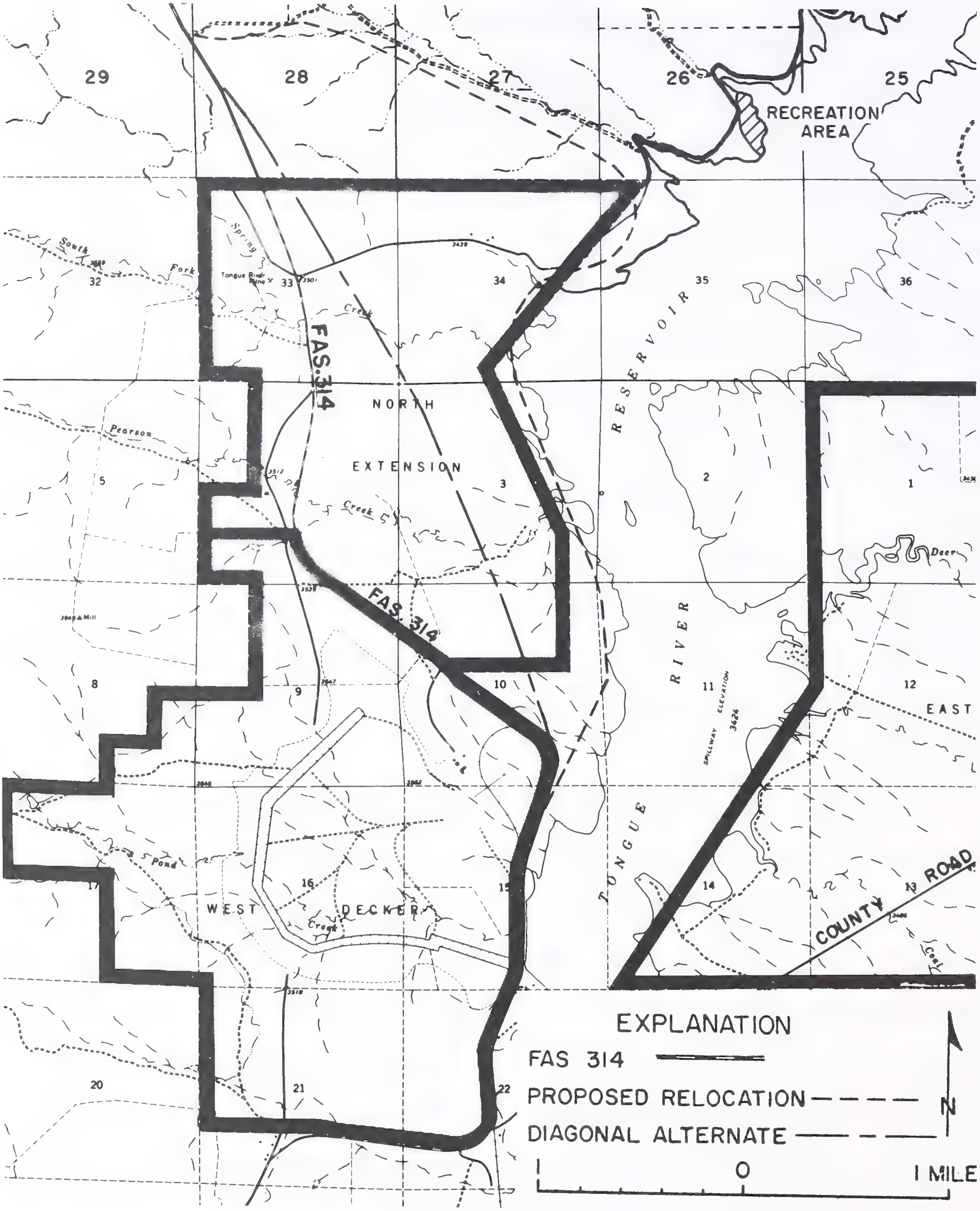


Figure 87.– Highway relocation alternate routes in the North Extension area.

b. No relocation of Route FAS 314

Not relocating the secondary highway has also been considered as an alternative by the Montana Highway Department. A grade separation to allow Route FAS 314 traffic to pass over intermine haul-road traffic would be required at Decker Coal Co.'s expense. Response by the Company to this alternative revealed that 2-3 million tons of recoverable coal would be left in place beneath the existing highway right-of-way. If the western mining limits were moved to the eastern right-of-way limit of the secondary highway, a total of 12-15 million tons of coal would not be recovered. Such potential losses of coal probably would be found by the Department of State Lands to constitute a violation of the Montana Coal Conservation Act. Because of the obvious problems, the alternative of not relocating Route FAS 314 is regarded as being impractical and is given no further consideration in this impact statement.

c. Diagonal alternate route

An alternate route considered to be feasible by the Montana Department of Highways would cross the eastern third of the North Extension mine on a diagnoal from southeast to northwest (fig. 87). The present location of Route FAS 314 within the mine boundary would not be changed until the advancing pits abutted the statutory highway buffer zone. Vehicular transport of coal from the North Extension mine to the preparation and loading facilities at the West Decker mine would require the construction of an overpass or underpass at the point where the haul road crosses Route FAS 314. This would reduce traffic hazards associated with an at-grade crossing.

A new relocated section of highway would be constructed across the previously mined and reclaimed area after the mining operation had advanced to the existing highway. When completed, traffic could be routed over the new highway, allowing closure of the old section and removal of the underlying coal. The mine then could continue its development westward.

A diagonal relocation would require the construction of approximately 3.67 miles of new highway compared to 6.46 miles for the Company's proposed alignment. In addition, travel distance between common points would be approximately 4.67 miles on the diagonal compared to 6.46 miles under the Company's proposal. This 1.79-mile difference could amount to an annual road-user savings of $23,000. Estimates made by the Montana Department of Highways indicate that the diagonal route and the grade separation could be constructed by the Decker Coal Co. for nearly $190,000 less than the Company's proposed west-shore alignment.

Because of the foregoing analysis, the Montana Highway Department has determined that the diagonal alternate route would be in the best interest of the motoring public (H. J. Anderson, Director, Montana Department of Highways, written communication to L. Berry, Jr., Commissioner, Department of State Lands, March 3, 1977, Appendix K). No final decision will be reached, however, until the Department of Highways receives through proper and necessary channels a highway relocation request from the Decker Coal Co. Implementation of the alternate mining plan in the North Extension area instead of the original proposal would not alter the Highway Department's favorable assessment of the diagonal alternate route (Robert Hall, Montana Highway Department, oral communication).

The Decker Coal Co. does not regard the diagonal alternate as being as feasible a route as their proposed west-shore alignment for the following reasons:

1. Regardless of whether the original or the alternate mining plan was implemented, the two pits within the mine area would be mined at different rates owing to production and coal-quality blending requirements. In addition, mine-limit configuration would make highway relocation and construction scheduling a practical impossibility.
2. Comprehensive surface-drainage design and implementation would be difficult, if not impossible, to meet.
3. A significant lapse of time for the entire length of road relocation to be available would lead to difficulties in reclamation of the mined surface as a normal part of the operation.
4. Decker Coal Co., while recognizing a savings in capital-construction costs, has indicated that total costs for the diagonal alternate would be significantly greater than the apparent initial savings.

(1) Environmental impacts of the diagonal route

The diagonal route would reduce the mileage to be maintained between common points and hence would reduce highway maintenance costs for Big Horn County. The shorter distance could amount to an annual road-user savings of $23,000.

Principal vegetation types intercepted by the diagonal route include sagebrush steppe, agricultural land, and grassland-sagebrush. Approximately 14.5 acres per mile of alignment would be taken from range or agricultural usage if this alternate plan is approved.

The diagonal route would cross only the channel of Spring Creek which, after reclamation, would carry the combined ephemeral flows of both the Spring Creek and Pearson Creek watersheds (fig. 19). The increased flow in this channel introduces the possibility of future highway flooding at this crossing as well as the potential for erosion and sedimentation resulting from construction activities. The impacts, however, should not be significantly different from those resulting from stream crossings under the original proposal.

Relocation of people, buildings, or businesses would not be anticipated if the diagonal route were approved, nor would this route take land from a publicly owned park, recreation area, or wildlife-waterfowl refuge of local, state, or national significance.

Based on a 20 year projected traffic volume of 250 vehicles per day at 50 miles per hour with 12 percent of all vehicles being trucks, a monograph analysis indicates that a noise sensitive location must be within 15 feet of the highway to exceed the design noise level L_{10} of 70 dBA. This level is acceptable for residences, schools, parks, and recreation areas. The nearest residence, which is owned by the Decker Coal Co., is approximately 4,000 feet from the diagonal alternate route.

(2) Mitigating or compensating measures

Mitigation of the impacts of relocating Route FAS 314 along the diagonal alternate route would be approximately the same as those for mitigating the Decker Coal Co.'s proposed realignment (p. 618-619).

(3) Adverse impacts that cannot be avoided if the diagonal alternate route is adopted

Adverse, unavoidable, impacts of relocating Route FAS 314 along the diagonal route would be approximately the same as those for the Decker Coal Co.'s proposed realignment (p. 633).

H. Technologic alternatives available to Federal and State authorities

1. Methods of extraction

Two alternative methods could be used to mine coal in the Decker area; they are underground mining and auger mining. Although both methods are presented here as technologic alternatives to the proposed methods of surface mining, they are not regarded as real alternatives inasmuch as it is highly unlikely that coal could be mined competitively or that the coal resource could be recovered adequately by these methods at the present time.

a. Underground mining

Underground mining is typically used in those areas where coal beds are too deeply buried to be mined economically by surface methods. Generally, beds are too deeply buried when the thickness of the overburden exceeds about 200 feet or when the thickness ratio of overburden to coal exceeds about 5 to 1. Underground mining requires a competent rock layer or bed above the coal to form a roof over mine openings. If the roof is too weak to support the overburden or if it fractures too easily under stress, underground mining may not be possible. This method typically requires large, regular blocks of coal that can be mined with automatic machinery. The local occurrence of faulting, folding, rapid thinning or thickening of the coal, or rock splits or partings in the coal can introduce severe operational problems. Present technology limits the extraction height in coal to less than 12 feet, because of the weak compressive strength of coal, which precludes the use of high pillars in thick beds. Also, coal pillars must be large in basal area compared to height to prevent collapse.

Coal beds that would be mined in the Decker area range from about 15 to 50 feet thick. Using available technology, only about a 10-foot section in each coal bed could be mined safely by underground methods, and about 50 percent of that 10-foot section must be left in place to support the roof. The amount of coal extracted using underground methods and equipment, therefore, would represent considerably less than 25 percent of the available coal in place. This amount compares to an expected recovery of 90 to 95 percent using surface-mining methods. Because both Federal and State laws require maximum feasible recovery of the coal resource as a condition for approval of a mining plan, underground mining would not be a viable alternative for surface mining in the East Decker and North Extension areas.

Moreover, underground mining is far more labor intensive than surface mining, requiring from 5 to 10 times as many men to produce the same tonnage of coal. This comparatively inefficient use of labor could have a considerable impact on the socioeconomic environment of the area.

b. Auger mining

Auger mining is essentially a supplemental method used to recover additional coal from a surface pit (1) when the overburden at the highwall becomes too thick to economically continue stripping operations or (2) in areas where steep terrain prevents the use of conventional surface methods.

The auger machine is essentially a large horizontal drill mounted on a mobile frame which bores a series of parallel holes into a coal bed exposed in a highwall or a hillside. Present equipment can cut horizontal holes up to 8 feet (96 inches) in diameter to depths of as much as 200 feet. A web of coal sufficiently thick to prevent collapse or subsidence must be left between adjacent holes. Recovery of coal accessible to the auger may be as much as 80 percent in areas where the auger can cut the full thickness of the bed. In general, however, the overall recovery in auger mining is only about 35 percent. Augers have not been used in thick coal seams, such as those that occur in the Decker area, because the method would result in excessive loss of coal.

The auger method probably would recover only about one-fourth of the accessible coal in the East Decker and North Extension area. As only about 1 percent of the coal in the proposed mine areas would be accessible to an auger, more than 99 percent of the coal to be mined in the Decker area would be lost, if augers alone were used. Accordingly, auger mining is not a real alternative to surface mining in the Decker area.

2. Alternative reclamation objectives and methods

The objective of the Montana Strip and Underground Mine Reclamation Act is to insure that strip-mined lands will be returned to a productive state in as short a time as practicable and that these lands are,"*** capable of feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation;" (Section 50-1045 R.C.M. 1947). Other criteria are set forth under the Reclamation Act describing the climatic and physical tolerances that reclaimed areas must be able to endure.

Unless other plans are approved by the Department of State Lands, an operator must, among other provisions: (1) Restore the affected land to the approximate contour of the original land surface, (2) return the topsoil to the top layer on the regraded surface, (3) prepare the soil upon completion of 1 and 2 above and plant a suitable permanent diverse vegetation cover, and (4) commence the reclamation activities as soon as possible after the strip-mining operation has begun (Section 50-1044, 50-1046, R.C.M. 1947).

The Act, however, also states: "An operator may propose alternative plans*** if the restoration will be consistent with the purpose of this act." Any alternative proposal, however, must be approved by the Department. In keeping with such a progressive attitude towards reclamation, the Department of State Lands "*** may encourage and conduct investigations, research, experiments and demonstration***." relating to strip mined lands (Section 50-1038 R.C.M. 1947).

Clearly then, technological reclamation alternatives can be permitted by the State of Montana for use at the proposed Decker mines. A discussion of such alternatives follows:

a. Grading

The Reclamation Act allows the mining operator to present recontouring plans other than recontouring to approximate the original land surface (Section 50-1044 R.C.M. 1947). All such grading schemes are subject to the approval of the Department of State Lands. Depending on the utilization intended, some alternatives may include: (1) Grading to achieve a homogeneous flattened plain for agricultural or industrial purposes, (2) grading to create a gently rolling surface with water empoundments for wildlife and/or livestock, (3) recontouring the land to create bluffs and buttes for use as wildlife habitat or to improve aesthetic values, and (4) a combination of any of the above methods.

Those parts of the Decker mine areas that lie adjacent to the Tongue River Reservoir present other possible grading alternatives. Some areas lowered as a result of coal removal, for example, could be graded to form marshlands that would serve as waterfowl habitat. Areas adjacent to the reservoir also could be reclaimed as recreation sites.

b. Retopsoiling

Topsoil removal methods proposed by the Decker Coal Co. include the "pick-up" of all materials regarded as topsoil from the surface to the lowest usable level, which may be to a depth of six feet or more. An alternative to such a method would be to separately salvage the A horizon as discussed under section IV. B. 5. Such a procedure would ensure the return of decaying organic matter and naturally occurring seed to the upper layer of the soil profile.

A second alternative would be to return the salvaged topsoil, insofar as possible, to graded and recontoured locations having the same general slope and aspect as the source areas of the soil materials. Soils often differ markedly from one site to another depending on the slope, aspect, and parent material from which the soils developed. Replacement of topsoil on areas having topographic conditions similar to those of the source areas could help ensure successful revegetation and the maintenance of vegetative diversity.

c. Vegetation selection

The Decker Coal Co. has proposed a reclamation seed mixture and application rate that purportedly would reestablish a permanent, diverse, vegetative complex on their East Decker and North Extension mine areas that would be suitable for grazing livestock (see section IV. B. 5). Should postmining land uses be proposed which are not predominantly for grazing livestock, a different vegetation complex may be preferred. Examples include the creation of monocultural croplands or wildlife management areas.

The introduction of additional nonnative species tolerant of the climatic and soil conditions in the Decker area may provide a superior vegetative cover and/or animal food source than the species proposed by the Decker Coal Co. Such nonnatives may not be present in the Decker vicinity now, either because their seeds have not yet migrated to the area or because of other environmental factors, such as fire, competition, natives of other continents, etc.

Problems may occur when a nonnative species is introduced onto a mined area. Such a species, for example, may not become established because an ecological requirement of the plant not recognized by reclamation specialists may be missing in the area. Conversely, an introduced species may be such a strong competitor that it significantly reduces the density or vigor of other desired species and, thus, may thwart the objectives of the reclamation plan.

The establishment of a vegetation complex that is consistent with the utilization plan for a reclaimed area depends upon proper species selection. Many alternate plans may be proposed and are deserving of close consideration in view of the important role that vegetation plays.

d. Seeding

Decker Coal Co. has proposed the use of a seed drill with rangeland modifications in reseeding retopsoiled areas. Pending Department of State Lands approval, however, other seeding methods could be used by the Company.

Broadcast seeding, whether by aircraft or ground vehicles, is less time consuming and may distribute species being seeded in a more random fashion than a seed drill. This method, however, leaves seed on the soil surface exposed to the prevailing climatic conditions and to consumption by birds, small mammals, etc. Seed germination and seedling establishment may be greatly reduced as a result.

Hydroseeding or hydromulching and seeding are also methods which may be employed to seed a reclaimed area. When seed and mulch are applied with water, some of the seed is trapped in the mulch. This effectively reduces the number of seeds available for reestablishment on a reclaimed site. Hydroseeding, on the other hand, may result in local areas of erosion which could lead to even greater erosion problems at a later time. As is the case with broadcast seeding, seed applied by hydroseeding also leaves some seed on the soil surface.

e. Irrigation

Another reclamation alternative would be to irrigate reclaimed mine areas. Owing to the proximity of the two proposed mines to the Tongue River Reservoir, irrigation is not only feasible but could be accomplished with relative ease.

The cost of maintaining irrigated lands might not be justified by the marginal increase in per acre returns caused by the input of irrigation.

Also, irrigation might introduce local sodic-soils problems and significantly increase the rate of leaching of the underlying spoil materials if excess water is used. Should this be the case, return to a vegetative complex consistent with that required by the Reclamation Act may be delayed by a greater time than would be needed under the Decker Coal Co.'s proposed reclamation procedures.

Conversion of postmining lands to irrigated crop or pasture would have varying affects on wildlife depending on the species. Pheasants and white-tailed deer for example, would probably increase in numbers inasmuch as they thrive in agricultural habitats, provided suitable "edge" and cover is available. Other species such as sage grouse are not as adaptable to agricultural environments.

3. Coal transportation systems

Alternatives to the proposed methods of transporting coal to loading facilities and to market include (1) the use of conveyor belts to move coal from the East Decker and North Extension mines to loading facilities at the existing West Decker mine, (2) the use of trucks or haulers to move coal from the East Decker mine to loading facilities at the West Decker mine, and (3) the use of slurry lines to move the coal from the Decker mines to market areas.

a. Conveyor belt

Use of a conveyor-belt system is generally considered to be a viable alternative to railroad transport of coal over distances of as much as 15 miles. Conveyor belts could be installed and used to move coal from the plant site at the East Decker mine to existing loading facilities at the West Decker mine. Similarly, a truck dump and crusher could be built near the site of the North Extension mine and a conveyor system used to haul coal directly from this crusher to the West Decker loading area. Use of a conveyor system and a central coal-handling facility, however, would require revision and enlargement of existing facilities at the West Decker mine.

A conveyor system could be built across the existing terrain without the surface disturbance required by railroad construction. Total land requirements, however, would be about the same (22 acres per mile). Crossings of existing rights-of-way might be restricted by above-grade conveyor equipment. The continuously operating mechanical equipment would have to be enclosed and isolated by fencing or other suitable means to protect the equipment from weather and to eliminate hazards to wildlife and people. A conveyor system generally presents a greater visual and noise impact than other transport systems because operation of the unsightly mechanical equipment is continuous and at a noise level that would pose a serious problem to any nearby residents. Also, malfunctions in equipment can cause local spills and fires.

Should a conveyor be installed to transport coal from the East Decker mine as an alternative to construction of a railroad spur, a separate transport system would be required to move heavy equipment and supplies into the East Decker mine area.

b. Trucks

Trucks, such as the 150-ton bottom-dump units to be used in the two proposed mines, could be used to haul coal from the East Decker mine to facilities at the West Decker mine. If so, the existing facilities must be enlarged to crush and load the additional volume of coal on unit trains. The large tonnage of coal to be transported daily would create a high-density truck traffic that would endanger both the operators and the general public using these roadways. It would be necessary, therefore, to construct and use a private haul road complete with a bridge over the Tongue River and an overpass or underpass at Route FAS 314. The land surface required for a heavy-duty haul road of this type would be several times greater than that required for operation of a conveyor system or a railroad. Motive-power requirements for a fleet of trucks would exceed by approximately nine-fold (Peat, and others, 1974) the power requirements of unit trains. The effect would be to increase accordingly both fuel consumption and consequent air pollution because of the increased exhaust emissions. Truck transport also would be more labor intensive than unit trains or conveyors and could add to the socioeconomic impact of the project.

c. Slurry pipeline

Slurry pipelines could be constructed to transport coal from the Decker mines either part way or to market areas in the Midwest and South. Such a project, however, probably would face severe legal and political challenges. To date, several slurry pipelines have been used successfully to transport crushed coal over appreciable distances. An example is the 275-mile-long Peabody Coal Co. pipeline in Arizona. Underground construction with only pumping and storage facilities visable at the surface would be most desirable. Burial also would protect the pipe against physical damage and the weather. It should be noted, however, that although the slurry pipeline has been shown to be an efficient method of transporting coal, some question still exists as to whether slurry pipelines can compete economically with existing rail transportation.

Impacts of this alternative include the following: (1) Slurry pipelines require about 700 acre-feet of water per million tons of coal transported. (2) This water must be separated from the slurry at the point of delivery, treated, and disposed of without polluting the existing environment. In the absence of a power plant or other suitable market, recovery of the transport water is not feasible, and the water must be discharged to waste after suitable treatment. (3) A right-of-way of approximately 12 acres per linear mile is required for the full length of the pipeline. (4) The pipeline could rupture and spill, polluting water courses or degrading local areas. (5) Provisions for transportation of mining equipment and supplies to the East Decker mine still would be necessary.

4. Utility system

No practical alternative exists to the use of electricity to power large mining equipment such as modern shovels and draglines. The large horsepower required to operate these machines can be supplied efficiently only by electric utilities. Diesel-powered equipment would be too bulky and too heavy to be adequately mobile and economically competitive. Electric power is normally distributed to the point of use by the most direct route to minimize transmission losses.

I. Development and use of alternate sources of energy

Coal from the Decker area is committed by contract to specific markets in Illinois, Michigan, and Texas where it would be burned in power generation plants to supply electricity to existing residential, commercial, and industrial users. Low-sulfur coal or equivalent non-polluting sources of energy are required to meet current and future more stringent EPA emission-control standards for power generation plants in these user areas. Decker coal would provide such a source of energy for a period of approximately 20 years for existing plants in Illinois and Michigan and for the plant under construction near Austin, Texas. Because of the existing or partially completed plants, their design specifications for coal having a given Btu content, and the present need for electric power in the user areas, most alternate energy sources may not be generally appropriate.

The following sections are summaries tailored to the replacement of 180 million tons of coal having an average heating value of about 9,500 Btu that would be produced from the proposed mining operations in the Decker area during the next 20 years. The amounts of coal, oil, natural gas, uranium, and shale oil necessary to provide this amount of power are shown in table 58.

The following sections draw on similar discussions in environmental statements for various energy developments, and from an expanded treatment of the subjects in a 1975 report entitled *Energy Alternatives: A Comparative Analysis*, by the Science and Public Policy Program, University of Oklahoma. The Oklahoma report was prepared for the Council on

Table 58.--Amounts of alternate fuels required to produce electrical power approximately equivalent to that produced from 180 million tons of coal from the Decker area[1]

Coal (8,000 Btu) = 214 million tons
Coal (12,000 Btu) = 142 million tons
Oil = 590 million barrels
Natural gas = 3.3 trillion cubic feet
Uranium = 6.1 million tons of uranium ore
Oil shale = 977 million tons of oil shale

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[1] Assumptions

1 ton coal = 19×10^6 Btu (9,500 Btu/lb)
1 barrel oil = 5.8×10^6 Btu
1 cubic foot natural gas = 1,032 Btu
1 ton ore = 3 pounds U_3O_8
1 pound U_3O_8 = 214×10^6 Btu
1 ton oil shale (@ 25 gal/ton) = 3.5×10^6 Btu
Fossil fuel power plants = 38% efficiency
Nuclear reactor power plants = 33% efficiency

Environmental Quality, Energy Research and Development Administration, Environmental Protection Agency, Federal Energy Administration, Federal Power Commission, Department of the Interior, and National Science Foundation. It considers various alternative sources of energy in the light of practicality, present technological state-of-the-art, future directions, cost-effectiveness, and environmental impacts. Because each alternate source is complex, a full treatment in this statement is impractical. Therefore, the report, Energy Alternatives: A Comparative Analysis, is incorporated by reference, as is the treatment of energy source options in the Final Environmental Impact Statement for the Proposed Federal Coal Leasing Program (U.S. Dept. of the Interior, 1975).

Because many impacts depend in detail on the specific site of coal mining or power generation, any comparison of large regions is necessarily generalized and subjective. Table 59 summarizes these subjective generalizations for possible alternate sources of power. It should be stressed, however, that those alternate sources of power listed in table 59 that show less impacts to the environment than the proposed operations in the Decker area would not necessarily provide real alternatives to the use of coal from the Decker area, given the practical constraints of time, economics, and existing facilities.

The following discussion attempts to appraise the feasibility of substituting alternate energy sources listed in table 59 for coal mined in the Decker area and transported to power-generation plants in Illinois, Michigan, and Texas.

1. Coal

Coal is the most abundant energy fuel in the United States; it underlies nearly 460,000 square miles in 37 states, constituting one-quarter of the world's supply and accounting for 80 percent of our proved energy resources. Proved resources of coal in the United States contain 125 times the total energy consumed nationally in 1970. Alternate sources of coal, therefore, could possibly be obtained from a number of areas.

a. Alaska

Much of the coal in Alaska occurs in the northern part of the State where long-term impacts on the fragile environment can be severe. Reclamation is difficult and less effective; mining conditions are harsh, and the influx of people for construction, operation, and support would have potentially severe adverse impacts. Moreover, transportation of this coal or power generated from this coal to user areas in Illinois, Michigan, or Texas would be impractical.

Table 59.--Environmental impacts of alternate energy sources relative to those of the proposed actions

Impacts[1]	Alternate sources												
	COAL						OIL AND GAS			NUCLEAR	OTHER		
	Alaska	Pacific Coast	Rocky Mtns.	Northern Great Plains	Interior and Gulf	East	On-shore	Off-shore	Import		Oil Shale	Geo-therm.	Hydro-power
Air quality	E	E	E	E	-	+	-	-	-	E	+	E	--
Water quantity	-	-	+	E	+	-	E	E	E	+	+	-	+
Water quality	--	-	E	E	+	E	E	E	E	-	+	-	-
Land: short-term	E	-	E	E	E	E	--	--	--	-	+	E	+
long-term	‡	-	+	-	-	-	-	-	-	E	+	-	‡
Socio-economic	+	-	E	E	-	-	+	+	‡	E	E	-	-

Explanation:

-- Considerably less impact
- Less impact
E Equivalent impact
+ More impact
‡ Considerably more impact

Notes:

[1] Air quality: Combines gaseous and particulate pollutants.
Water quantity: Consumptive use relative to quantity available as surface and ground water.
Water quality: Both surface and ground water.
Land - Short-term: Short-term commitment of land that would be reclaimed after extraction of fuel.
Land - Long-term: Long-term commitment of land either because of long-term facilities such as generating plants, or because of relatively ineffective reclamation of land disturbed during mining - in general, impacts on soils, vegetation, and wildlife are related to the amounts and duration of land disturbance.
Socio-economic: Combines effects of labor requirements, capital requirements, and current economic and political considerations.

All assume extraction, processing, and power generation techniques currently in use, and environmental protection at currently practiced levels.

b. Pacific Coast

Coal most suitable for power generation occurs in western Washington where water supplies are more abundant than in the Decker area, and problems with contamination of these supplies by sediment or toxic wastes should be less. Most coal in this area is obtained from underground mining, however, and resource recovery is comparatively low; many seams are discontinuous and difficult to mine. It is doubtful, therefore, that this area could provide the large tonnages required to substitute for coal mined in the Decker area.

c. Rocky Mountains

Winds and arid climate contribute to greater particulate air pollution from strip mines in western Wyoming, Utah, southwestern Colorado, Arizona, and New Mexico. Water availability in arid regions is lower, so impacts from consumptive uses would be relatively more severe. Disturbed land would be equivalent or somewhat less than in the Decker area because underground mines are more common, but revegetation of strip mines and spoil banks from underground mines would be less effective, leading to slower return to vegetative productivity. Coal from the Rocky Mountain area, however, could be used as an alternative source of energy.

d. Northern Great Plains

Alternative sources of coal from other mines in the Northern Great Plains area would produce impacts that should not be significantly different from those expected in the Decker area. Effects on air pollution and water quality should be essentially the same, but potential effects on aquifers may be greater if long belts of coal aquifers are disrupted along the basin margins. Although the average Btu value of coal elsewhere in the Northern Great Plains is generally less than in the Decker area, the land disrupted for equivalent energy would not necessarily be increased. Coal beds in other parts of the Northern Great Plains are often thicker than in the Decker area. Potential for revegetation elsewhere in the Northern Great Plains should be equivalent to or more favorable than in the Decker area. Accordingly, coal from other mines in the Northern Great Plains could feasibily be substituted for coal from the Decker area, although some uncertainty exists as to whether such alternate sources could be developed within the required time frame.

e. Interior and Gulf regions

These regions encompass the coal deposits between the Rocky Mountains and Northern Great Plains areas to the west and the Appalachian Mountains to the east. Even though much of the coal in the Interior and Gulf regions has high Btu values, the ratio of sulfur to Btu content is generally much higher than for western coals. Although mining these coal deposits would produce relatively few long-term adverse effects on land values and productivity, the comparatively high sulfur content generally results in sulfur dioxide (SO_2) emissions from power plants that exceed permissiable levels established by EPA. Under existing technology, therefore, most of these coal deposits could not be used as an alternative energy source for Decker coal.

f. East

Sulfur contents of eastern coals range widely, but the potential for air pollution from eastern coals burned in generating plants in Illinois, Michigan, and Texas generally would be higher than would result from burning coal from the Decker area. These coals, like those from the Interior and Gulf regions, generally would not meet EPA emission standards if burned in power-generation plants using available technology. Eastern coal deposits, therefore, are generally not feasible alternative energy sources for Decker coal.

2. Oil and gas

Oil, and particularly natural gas, are more environmentally desirable fuels for power generation than coal. Their production requires less commitment of land and fewer adverse impacts than coal for equivalent amounts of electric power generated. Coal-fired power-generation plants generally can be easily converted to burn oil or natural gas. The problems at present revolve around concerns for long-term supplies of oil and gas relative to demands, questions about priority uses for resources in short supply, and most recently, international economic and political stresses with respect to oil and gas prices and availability. Therefore, in spite of their desirability as "clean" fuels for power generation, oil and gas currently are not being urged as replacements for coal as boiler fuel. Indeed, the trend is to convert existing generating plants from oil or natural gas to coal because of fuel supply problems and priority use assignments by the Federal Energy Agency.

Oil and natural gas produced in the United States or imported from foreign countries could be used to replace the additional power that would be produced from coal mined in the Decker area. Current U.S. production of oil and gas during a single year far exceeds the cumulative total of energy that would be produced from coal mined over the next 20 years in the Decker area. If one assumes, however, that domestic oil and gas production must increase in order to provide energy self-sufficiency for the United States, additional production to replace coal from the Decker area probably would not be possible within the next 20 years. Substitution of oil and gas as an alternative energy source for Decker coal, therefore, is not considered to be feasible in light of present economic and political considerations.

3. Nuclear power

Electric power derived from the heat of fission reactions now constitutes about six percent of the nation's supply, and most generating plants now under construction are nuclear powered. The hope of recent years was that nuclear reactors would provide inexpensive and clean power in vast amounts, thus continuing the trend toward a society based on abundant cheap energy supplies. For a variety of reasons, the hope has not been realized. The world price of uranium, the basic material of nuclear fuel, has nearly doubled in the past few years, and indications are that the price will continue to rise in response to short supplies of known reserves relative to increased projected demands. Additional sources will be found, and increased prices will make known low-grade deposits economically attractive, but the fuel costs for fission reactors will not be dramatically less than for fossil fuels. Furthermore, costs for nuclear-fuel processing and generating plants have increased at a greater rate than for comparable fossil-fuel facilities, largely because of engineering problems, site constraints, and economic considerations. The advantages once attributed to nuclear power no longer are clear.

The nation has uranium ore and potential reactor sites to generate the additional power that would be obtained from coal from the Decker area during the next 20 years. Because lead time for licensing and constructing nuclear power plants now is at least 10 years, additional generating capacity probably would not be operational in the time-frame of this study. Nuclear power, therefore, is not a feasible alternative energy source for Decker coal.

4. Other alternate sources

Other alternate sources of energy have, to one degree or another, serious drawbacks as to their potential to generate amounts of power equivalent to that from additional development of coal from the Decker area. Solar energy is in its infancy as an alternate source for large-scale power generation. Despite hopes for eventual advances in technology that would make this apparently limitless and environmentally desirable source a true alternative, present outlooks are not favorable within the 20-year time-frame of this study. Similarly, sources such as tar sands, wind, tides, nuclear fusion, and organic waste are not valid alternatives because of either technologic or economic limitations. Each will contribute to future energy supplies as current problems are solved, but not at levels comparable to the development of coal in the Decker area within the next 20 years.

Shale oil, geothermal energy, and hydropower do not now appear to be effective alternatives to Decker area coal as sources of electric power, but each either is a proved source of larger amounts of power or is available as a resource in sufficient quantities to provide equivalent energy.

a. Oil shale

Energy from oil shale has the potential to replace the power that would be generated from coal from the Decker area, but recovery programs are not yet at operational levels. Prototype systems are under development in the Piceance Creek basin of western Colorado and the Uinta basin of northeastern Utah, but production will not begin until at least 1980, and production on a large scale is not expected within the next decade. It would be impractical, therefore, to regard shale oil as a replacement fuel for coal from the Decker area.

b. Geothermal energy

Heat from the earth can be used to generate electrical power, as demonstrated in existing plants in foreign countries and in California. The amounts of power now generated, however, are small relative to the potential from coal from the Decker area. Potential heat sources are abundant, particularly where the thermal differential is low, but technologic advances are required before the large potential can be realized as a valid alternative for large-scale power generation. Advances are being actively sought by government and industry, but they are unlikely to be achieved in time to provide replacement power in environmentally and economically acceptable forms within the 20-year time-frame of this study. Moreover, construction of transmission lines to carry the required power from geothermal sites to user areas in Illinois, Michigan, and Texas could not be completed within existing time constraints. Accordingly, geothermal energy is not presently regarded as a feasible alternative to the use of coal from the Decker area.

c. Hydropower

Power generated by water moving through turbine systems is a time-proven alternative to power generated by combustion of fossil fuels. Installed capacity in 1971 was about 52,000 megawatts, and in 1972 the Federal Power Commission estimated that the underdeveloped potential for hydroelectric generation in the lower 48 states alone is about 93,000 megawatts. Theoretically then, replacement of power generated by coal from the Decker area is possible. The additional capacity required to replace the power that would be produced from additional development of coal from the Decker area during the next 20 years would average about 2,360 megawatts per year.

In practice, however, adding capacity for hydroelectric power generation is constrained by several factors: (1) Sites with the greatest potential for high productive capacity and low development costs already have been exploited; (2) capital costs are high; (3) land-use and water-use priorities may inhibit development of the few remaining potential sites; and (4) irrigation, navigation, municipal and industrial uses, and flood control, uses which are not fully compatible with power-production needs, frequently are more important reasons for constructing dams. Even with pumped storage facilities to store water for peak demand periods, efficiency is low in response to seasonal and daily demand cycles. Owing to these factors, as well as long lead times for site acquisition, design, and construction of dams, power-generation facilities, and electric transmission lines, it is highly unlikely that additional generating capacity could be made operational within the time-frame of this study.

5. Federal development of coal resources

As stated in the Final Environmental Impact Statement for the Proposed Federal Coal Leasing Program (U.S. Department of the Interior, 1975, p. 833): it has been proposed that the Federal government actively conduct its own exploration for, and subsequent development or extraction of, energy fuels. The Federal government would not be limited in exploration by acreage or lease boundaries. This approach would result in more systematic inventories of coal resources and would provide more complete knowledge as to the extent of a given coal field.

Exploration and development by the Federal government would be responsive to the national energy emergencies. This alternative would probably require enabling legislation.

The Federal government would be subject to not only its own regulations, but to considerable public scrutiny. Environmental impacts would be similar to those of the proposal.

J. Alternatives that do not provide equivalent energy

1. Energy conservation

Nationwide efforts to conserve energy clearly are capable of saving the relatively small amount of additional energy available from coal in the Decker area. The total of about 3.4 quadrillion Btus that would not be developed from coal mined in the Decker area during the next

20 years pales beside the savings of 33.4 quadrillion Btus per year envisioned by the Office of Emergency Preparedness (OEP) as possible after 1980 (OEP, 1973). To achieve such a level of energy saving would require full implementation of all measures suggested by OEP, which is unlikely, but these measures would only have to be about one percent effective to offset additional production in the Decker area. Similarly the Project Independence report (Federal Energy Administration, 1974) estimates that conservation could reduce petroleum demand by 2.2 million barrels per day in 1985, which would amount to an annual savings of almost thirty times the projected annual production from additional development of coal in the Decker area. In practice, the magnitude of national demand forecasts, coupled with the national objective of energy self-sufficiency, seem to require significant conservation of energy regardless of whether sources are developed in the Decker area. It makes good sense to conserve energy derived from a finite supply of non-renewable fossil fuels, which when converted to useful work, pollute the ecosphere to some extent, and often severely.

Several recent studies have considered various energy conserving measures and have investigated the problems of implementation, environmental impacts, and comparative energy-efficiencies. They also have investigated the complex relationships among the often conflicting objectives of energy conservation, environmental protection, and balanced economic development. Two of these reports are incorporated in this statement by reference because of their expanded coverage and documentation in an extremely complex field:

1. Office of Emergency Preparedness, The Potential for Energy Conservation: Government Printing Office, Washington, D.C., 1972.
2. University of Oklahoma, Energy Alternatives: A Comparative Analysis: The Science and Public Policy Program of the University of Oklahoma, 1975.

The final environmental impact statement for the prototype oil shale leasing program (U.S. Department of the Interior, 1973) includes useful discussions of matters related to energy conservation in sections on the Energy Situation and Alternative Energy Policies in Volume II, Energy Alternatives.

The basic target of energy conservation is per capita energy demand, a figure that is increasing at a rapid rate. During the period 1950-1970 the per capita demand increased by nearly 50 percent; forecasts of per capita demand during the period 1970-2000 suggest a further doubling of the amount (U.S. Dept. of the Interior, 1972). The effects of population increase, although significant, are of less concern than these large increases in per capita demand.

Reduction in demand growth rate can be accomplished by decreasing the demand for goods and services that require energy to be produced and by increasing the efficiency of energy used to produce remaining goods and services. That sounds simpler than implementation would be; the United States has the largest and most sophisticated system of energy consumption in the world, and such a system is slow and difficult to change. The present economic structure and population distribution are an outgrowth of relatively inexpensive energy supplies with perhaps too little concern about future supplies; economic growth and material standards of living have soared as a result. Rapid changes to meet new perceptions of supplies and costs could have serious consequences to an economy already buffeted by conflicting requirements and would have short-term social consequences widely regarded as unacceptable. Therefore, conservation of energy must be viewed not only with respect to effectiveness, but also with respect to ramifications of implementation, including economic, social, and environmental repercussions. Time is a particularly vital consideration.

The OEP report on The Potential for Energy Conservation considers a variety of measures directed at the four major consuming sectors: transportation, residential/commercial, industry, and utilities. Implementation could be regulated by standards and regulations, tax incentives, and educational campaigns. Examples of the thrust of these projected measures are:

1. Transportation.--Promote and set standards for automobile energy efficiency (engines, weights, tires); promote mass transit and other improvements in load factors; provide incentives to decrease transportation demand that results from current patterns of population distribution; promote improved freight-handling systems;
2. Residential/commercial.--Encourage improved energy efficiency of structures (design, insulation, materials, windows) and of appliances (heating, cooling, lighting); promote adoption of good day-to-day conservation practices;
3. Industry.--Encourage improved energy efficiency of processes and equipment; promote recycling and reuse of materials where energy savings are demonstrable;

4. Utilities.--Use regulatory powers and incentives to smooth out demand curves and encourage conservation use; promote wise and efficient practices in construction, generation, and transmission techniques.

A measure common to all sectors is support for research and development to improve the energy efficiency of existing and new facilities, equipment, processes, and social attitudes and patterns.

A greatly simplified isolated example serves to illustrate the complex relationships among energy conservation, the economy, society, and environmental protection. Reducing the use of automobiles and increasing their efficiency clearly would conserve energy. Current population distribution, however, evolved over many years during which the cost of transportation by gasoline-powered automobiles was relatively low. Public policies encouraged this trend, and industries related to automobiles and their fuel become a major segment of the economy. The result is an economy and a social fabric that relies heavily on the automobile powered by an internal combustion engine, a machine that depends on a non-renewable fossil fuel of limited supply, which is also a major source of pollution.

Because of our reliance on the automobile for transportation, significant reductions in use must be offset in part at least by alternate means of transportation. The diffuse pattern of population distribution does not lend itself to currently available techniques of mass transit, except at extremely high costs. If costs are borne by users, the economic impacts could be crushing and unequally distributed; if borne by public funds, impacts still would be severe. Reduced use because of higher gasoline prices is effective, but because of the necessity for automobiles, sharply higher fuel costs simply work unequal hardships on individuals. Higher fuel costs affect commerce as well, and increased costs add to inflationary forces. If considerable reduction in automobile use is accomplished, lowered demand for automobiles and fuel would depress the major segment of our economy that directly or indirectly depends on their production, distribution, and service.

IX. CONSULTATION AND COORDINATION WITH OTHERS

A. Development of statement

This environmental impact statement was prepared by a Federal-State task force under the coleadership of the U.S. Geological Survey and the Montana Department of State Lands. Major inputs were provided by the Montana Departments of Natural Resources and Conservation, Highways, Health and Environmental Sciences, and Fish and Game; by the University of Montana Institute for Social Research; and by Dr. Paul Polzin, Economist.

Other Federal and State agencies providing consultation to the preparation of this statement include the following:

Federal agencies

Bureau of Land Management
Bureau of Outdoor Recreation
Bureau of Mines
Mining Enforcement and Safety Administration

State agencies

Montana Bureau of Mines and Geology
Montana Energy Advisory Council

Additional participation and assistance were obtained from many sources. The Decker Coal Co. provided data and information on their proposed activities and greatly facilitated field observations and data collection by task force members. Copies of draft environmental impact assessments for both the East Decker and North Extension areas prepared by VTN Colorado (1975a, 1975b) for the Decker Coal Co. were furnished task force members at the outset of this effort. Officials and employees of city and county governments in the impacted area also provided data and assistance. Comments of residents of the area and others were especially helpful to the task force in the preparation of this document.

B. Review of statement

In accordance with U.S. Council of Environmental Quality and Montana Department of State Lands rules and guidelines, copies of the draft statement were made available to the public for their comments and suggestions. Public hearings were held at Billings, Montana, at the Squirrel Creek School near Decker, Montana, and at Sheridan, Wyoming, on November 16, 17, and 18, 1976, respectively. In addition, comments were solicited from the following:

Federal agencies

*Advisory Council on Historic Preservation
*Soil Conservation Service
*Federal Power Commission
*Environmental Protection Agency
*Department of Health, Education, and Welfare
Interstate Commerce Commission
*Forest Service
*Federal Energy Administration
Federal Highway Administration
*Energy Research and Development Administration
*Department of the Army
Department of the Interior
- *Bureau of Outdoor Recreation
- *Bureau of Mines
- *Bureau of Land Management
- *Fish and Wildlife Service
- Bureau of Reclamation
- Bureau of Indian Affairs
- Mining Enforcement and Safety Administration

State and local agencies

Office of the Governor, Montana
Office of the Governor, Wyoming
Montana Agricultural Experiment Station
*Montana Department of Community Affairs
Montana Department of Revenue
Montana Energy Advisory Council
Montana Environmental Quality Council
*Montana State Historic Preservation Officer

*Indicates that written comments were received from this agency.

Montana Bureau of Mines and Geology
Board of County Commissioners, Big Horn County, Montana
Board of County Commissioners, Rosebud County, Montana
*Board of County Commissioners, Sheridan County, Wyoming
Mayor, city of Sheridan

Applicants

*Decker Coal Company

Other organizations

Sierra club
Environmental Defense Fund
Natural Resources Defense Council
National Audubon Society
*Northern Plains Resource Council
*Tri-County Ranchers Association
Friends of the Earth
Rosebud Protective Association
*Powder River Basin Resource Council
*Montana Coal Council
League of Women Voters of Montana
Environmental Information Center
Montana League of Conservation Voters
Tongue River Water Users Association
Crow Tribal Council
*Northern Cheyenne Tribal Council
Western Environmental Trade Association

*Indicates that written comments were received from this agency, company, or organization.

Written comments received by the Director, U.S. Geological Survey or the Commissioner, Montana Department of State Lands, together with responses, are presented in Appendix M. A summary of comments received at the public hearings, together with responses, are presented in Appendix N.

GLOSSARY

Access road. A paved surface roadway that provides access from a public roadway to a mine office and plant area.

Acre-foot. A unit for measuring volume, equal to the quantity of water or other material required to cover one acre to a depth of one foot or a volume of 43,560 cubic feet.

Active pit. The elongate trench or opening in a surface coal mine from which coal is actually being extracted.

Aeolian. Pertaining to or caused by wind.

Aggradation. The process of building up a surface by deposition of alluvium.

Alluvial. Geologic processes related to the action of flowing streams.

Alluvial soils. An azonal great soil group developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.

Alluvium. Clay, silt, sand, and gravel or other rock material transported by flowing water and deposited as sorted or semi-sorted sediments.

Ambient air. Air around the earth's surface.

Animal unit month (AUM). A measure of forage or feed requirement to maintain one animal (cow) for a period of 30 days.

Annual plant. A plant that completes its life cycle and dies in one year or less.

Aquifer. A formation, group of formations, or part of a formation such as a sandstone or coal bed, that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Aquifer recharge. Water that enters an aquifer from external sources. The ultimate source of all recharge is from surface water.

Archaeological excavation. On sites that will be destroyed as a result of construction, excavation is often the only means of information salvage. Sites are selected for excavationon the basis of a survey. The intent is to select a representative sample of every type of site from every time period. The sites so selected typically range from 5-10 percent of the sites located in the survey. All excavated materials are subjected to intensive laboratory analysis, description, and publication. By definition it is in itself destructive activity, as the inplace value of the resource is destroyed through excavation.

Archaeological inventory. An inventory is an attempt to locate every site within a specified region, or in the case of a right-of-way, every site along the right-of-way. The inventory requires covering the surface on foot, horseback, or vehicle, in transect intervals of 100 yards or less. An inventory produces as the end product an itemized description of each site, its location on a suitable detailed map, a photograph, and a collection of artifacts from the surface of each site.

Archaeological reconnaissance. A cursory examination of a region to locate actual sites as a means of determining site situations utilized and site types present. Normally such a study is conducted according to some sampling design.

Archaeological resources. Objects and areas made or modified by man and the data associated with these artifacts and features. These resources rest in or on the ground.

Archaeological survey. A survey is an extension of an inventory. In addition to site location the site collections are analyzed, and each site is assigned to a culture period or periods. The analysis includes laboratory study of artifacts: cleaning, labelling, typological analysis, etc. If acquired, any datable samples are submitted for dating. The site types and artifacts are described in a published report which synthesizes all of the known archaeological data in the region studied.

Artesian well. A well that derives its water from an artesian or confined water body. The water level in an artesian well stands above the top of the artesian water body tapped by the well.

Artifact. A material object made or modified in whole or in part by man. Among the most common artifacts at archaeological sites are stone tools, chips, projectile points, and similar lithic debris.

Assessed valuation. The taxable valuation established by an official tax assessor for a unit of property, including improvements. Assessed valuation is generally set as a percentage of the indicated market value. The assessed value times the mill levy establishes the amount of the annual tax.

Available water-holding capacity (soils). The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil.

Average annual precipitation. An average of the yearly precipitation, usually expressed in inches of water that fall or are computed to fall at a point or on an area during a specified number of calendar or water years.

Backfill. The process of filling, or the material used to fill, a surface-mine pit.

Background (or baseline) total suspended particulate (TSP) levels. The amount of total suspended particulates occurring naturally in any geographic area. Background TSP levels in eastern Montana are measured at sites in areas removed from roads, plowed fields, or other human activity insofar as possible.

Badlands. An extremely rough dissected terrain often nearly devoid of vegetation and characterized by an intricate maze of narrow ravines and sharp crests and pinnacles.

Baseline data. Information collected prior to the initiation of an environmental analysis which forms a basis for the determination of environmental impacts.

Bed. A subdivision of a stratified sequence of rocks, lower in rank than a member or formation, internally composed of relatively homogeneous material exhibiting some degree of lithologic unity, and separated from the rocks above and below by visually or physically more or less well-defined boundary planes; "the smallest rock-stratigraphic unit recognized in classification."

Bedrock. The more or less solid rock in place either on or beneath the surface of the earth.

Belt conveyor. A moving, endless belt that rides on rollers and on which materials can be carried for various distances.

Benthic. Bottom-dwelling.

Big game. Large mammalian species managed by a state agency for sport hunting.

Biomass. Living weight.

Box cut. The initial pit in a strip mine where no open side exists; this results in a highwall on both sides of the pit.

Brood. The young hatched or cared for at one time.

Browse. The part of leaf and twig growth of shrubs, woody vines, and trees available for animal consumption.

Btu. Abbreviation for the British thermal unit. Amount of heat needed to raise 1 pound of water 1 degree Fahrenheit; equivalent to 252 calories.

Carbonaceous. Said of a rock or sediment that is rich in carbon; coaly.

Carnivore. Flesh eater.

Carrying capacity. The uppermost limit of a specific area's ability to support a given animal population.

Chemical quality of water. A term that embodies all the chemical and physical properties or attributes of water which are imparted to the water by the amounts and kinds of chemical constitutents in colloidal suspension or dissolved in the water.

Climax. The plant community which essentially gains permanent occupancy of a habitat and perpetuates itself there indefinitely unless disturbed by outside forces.

Claystone. An indurated rock composed largely of clay particles; differs from shale in not being fissile.

Clinker. Baked or fused rocks as a result of the natural burning of underlying coal beds; generally red to reddish brown in color.

Coal. A solid, brittle, dark brown to black, combustible, carbonaceous rock formed by the partial to complete decomposition of vegetation.

Coal Reserve Base. The Coal Reserve Base for subbituminous coal is defined by the U.S. Bureau of Mines and U.S. Geological Survey (1976) as including only coal that is in beds 5 feet or more in thickness, under less than 1,000 feet of overburden, and within 3 miles of the outcrop or a point of measurement on the coal bed (the combined Measured, Indicated, and Inferred categories of geologic assurance). The Coal Reserve Base in the Decker area occurs in eight coal beds; they are the Roland, Smith, Anderson, Dietz 1, Dietz 2, Canyon, Wall, and A beds.

Colluvium. Loose, unconsolidated clay, silt, sand, and gravel at the foot of a slope, brought there chiefly by gravity.

Community. An aggregate of organisms which form a distinct ecological unit. Such a unit may be defined in terms of plants, animals, or both.

Concentration. A term used to describe the amounts of a material or substance in relation to the total mixture. In this report concentration is expressed in parts per million and in equivalents per million.

Coniferous. A tree or shrub of the coniferae (pine, fir); reproductive structures contained in cones; leaves (needles) green through the year.

Consumptive use. The quantity of water discharged to the atmosphere or consumed in connection with domestic use, vegetative growth, food processing, or an industrial process.

Contour furrows. Furrows plowed approximately on the contour on pasture or rangeland to prevent soil loss and increase infiltration.

Cubic feet per second (ft^3/s). A unit expressing rates of discharge, equal to the discharge through a rectangular cross section, one foot wide and one foot deep, flowing at an average velocity of one foot per second.

Cultural resources. Objects, structures, sites, and districts that pertain to native peoples, or other communities; they are generally classified as historic and prehistoric (often referred to as archaeologic). Such areas are important because of their education, interpretive, and scientific value, because they are vital to the preservation of a subculture, or because they are representative examples.

Cumulative impacts. The combined impacts as a result of the disturbance of more than one area. Cumulative impacts may be greater than the algebraic sum of the individual impacts.

Dancing ground. Area selected by male sharp-tailed grouse for spring courtship displays.

Deciduous. Plants which lose leaves during certain seasons (usually fall), cf. coniferous.

Degradation. The wearing down or away, and the general lowering or reduction of the earth's surface by the natural processes of weathering and erosion.

Demography. The study of the vital statistics of a population.

Dip. The angle that a structural surface, e.g., a bedding or fault plane, makes with the horizontal, measured perpendicular to the strike of the structure.

Discharge. The flow of water in a stream or from an aquifer.

Dissolved solids. Solids that originate mostly from rocks and are in solution. Some colloidal material is treated as if it were in solution in determining dissolved solids. The total dissolved mineral constituents of water.

Dragline. A type of excavating equipment which casts a cable-hung bucket and collects dug material by pulling the bucket with a second cable.

Dry farming. Farming without irrigation.

Ecology. The study of the relation of organisms or groups of organisms to their environment; animals and plants in their relation to each other.

Ecosystem. Complex self-sustaining natural system which includes living and nonliving components of the environment and the interactions that bind them together. Its functioning involves the circulation of matter and energy between organisms and their environment.

Ecotone. The zone of intergradation where two plant communities come into contact; i.e., forest bordering grasslands.

Edaphic. Conditions or characteristics of the soil (chemical, physical, or biological) that influence organisms.

Effluent. Water and contained soluble and suspended solids discharged from a body of surface water or ground water.

Embayment. An indentation in a shoreline forming an open bay.

Eolian soil material. Soil material accumulated through wind action.

Ephemeral. Lasting for only a short period of time.

Ephemeral stream. A stream that flows only for a part of the year or in direct response to snow melt or storm runoff.

Erosion. The removal of surface materials by the force of flowing water.

Escarpment. A long, more or less continuous cliff or relatively steep slope facing in one general direction breaking the general continuity of the land by separating two level or gently sloping surfaces, and produced by erosion or by faulting.

Evaporation. The process by which water is changed from the liquid or solid state into the vapor state.

Evapotranspiration. The process by which water is withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Exotics. Imported floral or faunal species, nonnative.

Fault. A surface or zone of rock fracture along which there has been displacement from a few inches to many feet.

Fauna. All animals of a particular period or region, taken collectively.

Flood. Any relatively high streamflow that overtops the natural or artificial banks in any reach of a stream. A 100-year flood is the highest peak discharge that occurs at a given location on the average of once each hundred years.

Flora. All plant life of a particular period or region.

Fluvial. Formed or produced by flowing water.

Forb. Any herbaceous plant other than those that are grass or grass-like.

Formation. A distinctive bed or sequence of rocks selected as a convenient unit for mapping, description, and reference.

Fossil. Any remains, trace, or imprint of a plant or animal that has been preserved by natural processs, in the earth's crust since some past geologic time; any evidence of past life.

Fossiliferous. Containing fossilized material.

Friable. Easy to break, crumbling naturally, poorly cemented so as to crumble.

Fugitive dust. Solid airborne particulate matter emitted from any source, other than an opening, which channels the flow of air contaminants and then exhausts the contaminants directly into the atmosphere by natural forces or by mechanical processes such as crushing, grinding, milling, drilling, demolishing, shoveling, conveying, covering, bagging, sweeping, etc.

Gaging station. A particular site on a stream, canal, lake, or reservoir where systematic observations of gage height or water discharge are obtained. A streamflow gaging station is a gaging station on a stream.

Gallons per minute (gal/min). A unit expressing rates of discharge. One cubic foot per second is equal to 448.8 gal/min or 646,272 gal/d (gallons per day).

Geologic structure. Deformed rock resulting from stresses generated in the earth's crust.

Geomorphic. Pertaining to the form of the earth or of its surface features.

Geomorphology. The science that treats the general configuration of the earth's surface; specifically the study of the classification description, nature, origin, and development of present landforms and their relationships to underlying structures, and of the history of geologic changes as recorded by these surface features.

Grade. A degree of inclination or a rate of ascent or descent with respect to the horizontal; it is expressed as a ratio (vertical to horizontal) in the form of a fraction (such as ft/mi) or a percentage (of horizontal distance).

Ground water. That part of subsurface water that completely saturates the rocks and is under hydrostatic pressure.

Ground water, confined. Confined ground water is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

Ground water, unconfined. Unconfined ground water is water in an aquifer that has a water table.

Ground-water recharge. Same as aquifer recharge.

Habitat. A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

Haul road. Improved road, generally with a clinker surface, used to haul coal from the ramp road to the coal-dump area.

Herb. A seed-producing plant (annual, biennial, or perennial) that does not develop persistent woody tissue but dies down at the end of a growing season.

Herbivore. Feeds on vegetation.

Highwall. The unexcavated face of exposed overburden and coal in a strip-mine pit.

Historic site. Any place associated with a significant event, an important person, or a cultural activity of the past. Historic in most cases is 50 years old or older, except for rare instances where exceptional events have taken place, such as the site of the first atom bomb detonation.

Hydraulic conductivity. The amount of water that will move in one day under a hydraulic gradient of one foot per foot through a one square foot area measured at right angles to the direction of flow.

Hydraulic gradient. Pressure gradient; rate of change of pressure head in an aquifer per unit of distance of flow at a given point and in a given direction.

Hydrostatic head. The height of a vertical column of water, the weight of which, if of unit cross section, is equal to the hydrostatic pressure at a point.

Indirect sources. Sources related to induced motor vehicle activity, such as commercial facilities, public and private office buildings, parking lots, roadway, or other structure where patronage relies wholly or in part, on the use of motor vehicles; also, sources which are not emitters of air contaminants by themselves but, by the nature of activities and/or processes associated with them, give rise to air contamination.

Inmigration. A population mobility factor representing movement into a statistical unit for the purposes of becoming a permanent resident.

Insectivore. Feeds on insects.

In situ. A Latin phrase meaning "in place". Arcaheologically it refers to an artifact or object found in its original undisturbed position.

Interburden. The rock lying between the coal beds to be mined.

Inversion. A meteorological condition in which the temperature of the atmosphere rises with increased elevation instead of falling (a negative temperature lapse rate). A special problem in polluted areas because the contaminating substances cannot be dispersed.

Invertebrate. An animal without a backbone or spinal column.

Ion. An electrified particle formed when a neutral atom or group of atoms loses or gains one or more electrons. If electrons are lost, the particle is positively charged and is called a cation. If electrons are gained, the particle is negatively charged and is called an anion. When a molecule goes into solution, it breaks down into one or more cations and one or more anions. For example, a molecule of the mineral gypsum or calcium sulfate ($CaSO_4$), when dissolved in water, disassociates into a calcium ion (CA^{++}) and a sulfate ion (SO_4^{--}).

Irrigation. The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.

Joint. A surface of actual or potential fracture or parting in a rock, without displacement; the surface is usually plane and often occurs with parallel joints to form part of a joint set.

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Landform. A discernible natural landscape, such as a floodplain, stream terrace, plateau, velley, etc.

Landslide. A general term covering a wide variety of mass movement landforms and processes involving the moderately rapid to rapid downslope transport, by means of gravitational body stresses, of soil and rock material in masses.

Leach. To dissolve out by the action of a percolating liquid.

Leachate. Percolating liquid containing dissolved constituents leached from spoil materials.

Leguminous. Pertaining to a plant of the family Leguminosae (Fabaceae); clover, vetches, alfalfa.

Limnology. The scientific study of the physical, chemical, meteorological, and biological conditions in fresh waters.

Mill levy. (Also referred to as tax rate). The rates of tax to assessed value set by a taxing jurisdiction for determining the annual tax accruing from a unit of property. A mill is one tenth of one cent, or one-thousandth of one dollar. The tax rate (mill levy) is generally expressed in terms of dollars per $1,000's of assessed value.

Nongame. Wildlife species not managed by a state agency for sport hunting.

Normal fault. A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of the fault is usually 45-90^{0}.

Opacity. The degree to which an air contaminant emission obscures the view of an observer, expressed in a percentage of the obscuration, and/or the degree (percent) to which light transmittance of a light beam is reduced or affected by an air contaminant emission.

Overburden. All the earth and other materials which lie above a natural deposit of minerals.

Outmigration. A population mobility factor representing movement out of a statistical unit by those considered to be permanent residents.

Perennial stream. One which flows continuously from source to mouth during most years.

Permeability. (1) The quality of a soil horizon that enables water or air to move through it. (2) The property or capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

(pH) Hydrogen-ion concentration. The negative logarithm of the concentration of hydrogen ions. The pH is a measure of the activity of the hydrogen ions and thus is a numerical value or measure of the alkalinity or acidity of the water. Ordinarily, water having a pH of 7.0 is regarded as neutral; a pH lower than 7.0 indicates acidic properties; and a pH higher than 7.0 indicates alkalinity. However, a water that is acid, alkaline, or neutral according to the pH scale is not necessarily the same by another standard.

Phenology. The interrelations of climate and periodic biological phenomena; usually refers to budding and flowering in plants.

Phreatophyte. A plant that habitually obtains its water supply from the zone of saturation.

Physical properties (of soils). Those characteristics, processes, or reactions of a soil which are caused by physical forces and which can be described by or expressed in physical terms or equations.

Porosity. The property of a rock, soil, or other material containing interstices. It is commonly expressed as a percentage of the bulk volume of material occupied by interstices, whether isolated or connected.

Potentiometric surface. A surface that represents the static head. It is defined for an aquifer by the levels to which water will rise in tightly cased wells. The water table is a particular type of potentiometric surface.

Precipitation. The discharge of water, in liquid or solid state, out of the atmosphere, generally upon land or water surface. The term is also used to designate the quantity of water that is precipitated.

Primary consumer. Animals solely dependent on plants as a food source.

Producer. Autotrophic organisms, largely green plants, which are able to manufacture food from simple inorganic substances.

R. Range, one of the north-south rows of townships in a U.S. public-land survey. (Plural: Rs.).

Rainfall. The quantity of water that falls as rain only. The term is not synonymous with precipitation.

Rain shadow. An area on the lee side of a mountain range which receives low precipitation because most of the moisture in the prevailing air masses is lost in crossing the mountain range.

Ramp road. Temporary road, generally with a clinker surface, used to connect the active pit with a haul road.

Range. The area occupied by a given species for all or a portion of their lives.

Raptor. Birds of prey with sharp talons and strong notched beaks; hawks, owls, vultures, etc.

Recharge. The process by which water moves into an aquifer, or the amount of water that moves into an aquifer.

Reclamation. The process of reconverting disturbed lands to their former uses or other approved uses in accordance with Federal and State statutes and regulations.

Reserves. Known deposits of coal that can be profitably mined. Tonnage generally known within 20 percent.

Residual soil. Soil presumed to have developed in place by weathering from the consolidated rock on which it lies.

Resources. Includes reserves and other coal deposits that may become profitable to mine. Tonnage imperfectly known.

Restoration, soil. Returned to the original condition.

Revegetation. The establishment of plant cover on lands made barren by the activities of man.

Rhizomatous. Bearing horizontal subterranean stem, usually rooting at the nodes and becoming upcurved at the apex, giving rise to a new plant.

Riparian. Situated on or pertaining to the bank of a river, stream, or other body of water.

Riprap. A layer of large, durable, specially selected and graded, broken rock fragments thrown together irregularly (as in deep water or on a soft bottom) to prevent erosion through wave action or strong currents, and thereby preserve the shape of a surface, slope, or underlying structure. It is used for irrigation channels, river-improvement works, spillways at dams, and shore protection.

Rookery. A breeding ground or haunt of gregarious birds or mammals.

Runoff. That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man, in or on the stream channels or on the drainage area.

Saline soil. A soil containing sufficient soluble salts to impair its productivity.

Salinity. A measure of the soluble salt content; generally referred to as high, medium, or low.

Sand. A rock fragment or detrital particle smaller than a granule and larger than a coarse silt grain, having a diameter in the range of 1/16 to 2 mm (62-2,000 microns, or 0.0025-0.08 in., or 4 to -2 phi units).

Sandstone. A medium-grained, clastic sedimentary rock composed of abundant and rounded or angular fragments of sand size set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material (commonly silica, iron oxide, or calcium carbonate); the consolidated equivalent of sand.

Saturated zone. That part of water-bearing material in which all voids, large and small, are filled with water under pressure greater than atmospheric.

Savanna. Woody plants 7-25 ft tall or taller, scattered individually over a rather dense lower stratum of herbs or lichens.

Scoria. Same as clinker.

Scraper. A stone implement used to scrape leather, smooth wood, etc.

Sec. Section; a parcel of land that is one square mile or 640 acres. (plural: secs.).

Secondary consumer. Heterotrophic organisms that feed on other heterotrophs.

Sediment. Fragmented material that originates mostly from rocks and is transported by, suspended in, or deposited from water or air.

Sedimentation. The processes by which sediments are transported and deposited.

Sediment discharge. (1) The rate at which dry weight of sediment passes a section or a stream, or (2) the quantity of sediment, as measured by dry weight or by volume, that is discharged in a given time.

Sediment station. A particular site on a stream or other waterway where a record of sediment discharge is obtained.

Sediment yield. A unit for expressing the discharge of dissolved solids or sediment from an area. Sediment yield is usually given in tons or acre-feet per square mile per year.

Semiarid. A term applied to regions or climates where moisture is normally greater than under arid conditions, but still definitely limits the growth of most crops.

Settling pond. An excavation or impoundment used to remove solids suspended in water by slowing velocity and allowing the suspended particles time to settle.

Shale. A fine-grained, indurated, detrital sedimentary rock formed by the consolidation (as by compression or cementation) of clay, silt, or mud, and characterized by finely stratified (laminae 0.1-0.4 mm thick) structure and/or fissility that is approximately parallel to the bedding (along which the rock breaks readily into thin layers), and that is commonly most conspicuous on weathered surfaces, and by a composition with an appreciable content of clay minerals or surfaces, and by a composition with an appreciable content of clay minerals or derivatives from clay minerals, and with a high content of detrital quartz.

Silt. (soil) A soil-texture term used in the United States for a rock or mineral particle in the soil, having a diameter in the range of 0.02-0.05 mm; prior to 1937, the range was 0.005-0.05 mm. The diameter range recognized by the International Society of Soil Science is 0.002-0.02 mm.

Siltstone. An indurated or somewhat indurated silt having texture and composition, but lacking the fine lamination or fissility, of shale.

Slick spots. Small areas that are slick when wet because of a high content of alkali or of exchangeable sodium.

Slurry. A mixture of fine coal in water. Commonly pumped through pipelines at processing plants or to consumption points.

Small game. Small animals managed by a state agency for sport hunting; e.g., rabbits, grouse, pheasants.

Soil. Unconsolidated material underlying the surface that has been sufficiently modified and acted upon by physical, chemical, and biological agents that it will support plant growth.

Soil horizon. A layer of soil approximately parallel to the land surface with observable characteristics that have been produced through the operation of soil-building processes. The A horizon is the upper part and contains the most organic materials. The underlying B horizon is generally less well developed and contains more clay. The C horizon is unconsolidated, essentially unweathered parent materials.

Social services. Those facilities necessary for the existence of a town such as schools, roads, medical services, and facilities normally supported by public funds.

Sodium-adsorption-ratio (SAR). Related to the adsorption of sodium by the soil and is an index of the sodium or alkali hazard of the soil or of water used to irrigate the soil. In the computation of SAR, concentrations of constituents are in equivalents per million.

$$SAR= \frac{Na+}{\sqrt{\frac{Ca++ + Mg++}{2}}}$$

Soil association. A mapping unit used on general soil maps in which two or more defined taxonomic units occurring together in a characteristic pattern are combined on the map into one unit. The components of the soil association may or may not be contrasting.

Soil series. A group of soils having horizons similar in characteristics and arrangement in the soil profile, except for texture of the surface portion.

Specific conductance. A measure of the capacity of a solution to conduct an electrical current, generally expressed in micromhos per centimeter at 25°C. It is one million times the reciprocal of specific resistance at 25°C. Specific resistance is the resistance in ohms of a column of water one centimeter long and one square centimeter in cross section. Because the specific conductance is related to the number and specific chemical types of ions in solution, it can be used for approximating the salinity of the water.

Spoil. The overburden and interburden removed in strip mining. Debris or waste material from a strip mine.

Steppe. An extensive area of natural, dry grassland.

Stratigraphic unit. A stratum or body of strata recognized as a unit in the classification of the rocks of the earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Stratigraphy. The branch of geology that deals with the definition and description of major and minor natural divisions of rocks (mainly sedimentary, but not excluding igneous and metamorphic) available for study in outcrop or from subsurface. It involves interpretation of these features of rock strata in terms of their origin, occurrence, environment, thickness, lithology, composition, fossil content, age, history, paleogeographic conditions, relation to organic evolution, and relation to other geologic concepts.

Streamflow. The water discharge that occurs in a natural channel, whether or not the water discharge is affected by regulation or underflow.

Strutting ground. Area selected by male sage grouse for spring courtship displays.

Subbituminous coal. Nonagglomerating coal having a heat value of 8,300 to 13,000 Btu on a moist, mineral-matter-free basis. Intermediate in rank between lignite and bituminous coal.

Succession. The progressive development of vegetation toward its highest and most stable ecological expression, the climax; replacement of one plant community by another.

Suffrutescent. Slightly or obscurely shrubby.

Surface coal mine. A mine in which the overlying soil and rock are removed or stripped to expose and mine the coal.

Surface water. Water that rests on the land surface.

Suspended sediment. Sediment that is supported by the upward components of turbulent currents, or by colloidal suspension if the sediment particles are very small.

T. Township, a tract of land that is bounded on the east and west by meridians six miles apart at its south border, has a north-south length of six miles, and forms one of the chief divisions of a U.S. public-land survey. (Plural: Tps.).

Talus. (1) Talus slope. (2) Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep, rocky slope.

Temperature inversion. A layer in which temperature increases with altitude. The principal characteristic of an inversion layer is its marked static stability, within which very little turbulent exchange can occur.

Terrace. Any long, narrow, relatively level or gently inclined surface, generally less broad than a plain, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope.

Topoedaphic. The combination of topographic and edaphic factors that help influence plant distribution and/or plant growth characteristics in a given area.

Topography. The relative positions and elevations of the natural or manmade features of an area that describe the configuration of its surface.

Topsoil. Natural earth materials at or adjacent to the land surface, with physical and chemical characteristics necessary to support vegetation.

Total dissolved solids (TDS). The dissolved mineral constituents of water.

Total suspended particulates. Total solid materials in the air, ranging in size from less than one micron (u) to approximately 100 u. A micron is one thousandth of a millimeter. Units of measurement of TDS are micrograms per cubic meter (ug/m^3) of air.

Transmissivity. Rate at which ground water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Equivalent to hydraulic conductivity multiplied by the saturated thickness of the aquifer.

Transpiration. The process by which water moves from living plants to the atmosphere.

Unit train. A train made up entirely of coal cars carrying coal directly from the loading place to point of delivery. A unit train in the Decker area consists of 100 cars, each carrying 100 tons of coal.

Upland. (1) The higher ground of a region, in contrast with a valley, plain, or other low-lying land, a plateau. (2) The elevated land above the low areas along a stream.

Underflow. Ground water moving downstream through pervious alluvium that underlies the bed of a stream or river.

Use (water). The total quantity of water pumped, diverted, applied, or utilized for any purpose.

Vertebrate. An animal having a backbone or spinal column.

Water table. The water table is that surface in an unconfined water body at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists.

Water type. A term used to denote the predominate cations and anions in water. Whether certain cations (calcium, magnesium, sodium, and potassium), and certain anions (bicarbonate, sulfate, and chloride), predominate depends on the concentrations in equivalents per million and the relation of the concentration of the individual ions to each other. For example, if the concentration of sodium makes up most of the total cations, and the concentration of bicarbonate makes up most of the total anions, the water is classified as a sodium bicarbonate type. However, if the second most abundant cation or anion is more than half the most abundant cation or anion, and the third most abundant cation or anion is more than half the second, they are included in the water-type classification in order of magnitude. Examples of these more complex water types would be calcium magnesium bicarbonate, calcium magnesium bicarbonate sulfate, and sodium magnesium calcium chloride sulfate.

Water yield. The runoff from a drainage basin.

Xerophyte. A plant adapted to dry conditions of air and soil.

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